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Rare, Threatened and Endangered Vascular Plants of the Aberdeen Proving Grounds, Harford and Baltimore Counties, Maryland

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Abstract.- The vascular flora of the Aberdeen Proving Grounds in Harford and Baltimore Counties, Maryland was surveyed for occurrences of rare, threatened and endangered vascular plants during the growing seasons of 1998 and 1999. These searches led to the discovery of 41 state ranked vascular plant species and the first collection from Maryland of *Spirodela punctata*, a free-floating aquatic duckweed.

Introduction

The Aberdeen Proving Grounds (APG) occupy 31,714 ha of northeastern Maryland along the shore of the Chesapeake Bay in Harford and Baltimore Counties. The Harford County portion of APG is divided by the Bush River into the Edgewood area to the south, and the larger Aberdeen area to the north. Baltimore County contains only a small portion of the APG, comprised of Carroll Island and Graces Quarters peninsula extending out to Battery Point. Since much of APG is less than 7.5 m elevation above mean sea level, numerous wetlands occur throughout the property. Upland areas are comprised of mowed lawns, young deciduous woodlands, and some large areas of meadow that are managed to various degrees.

Hunt (1974) places APG within the embayed section of the low-lying Atlantic Coastal Plain Physiographic Province. The soils of Harford County are from Upper Tertiary formations (Hunt 1974), and are dominated by silt loam, sandy loam, and mucky peat of alluvial, eolian, and fluvio-marine parent material (Ranson and Levan 1998).

The APG falls within the Temperate Continental climate zone delineated by Trewartha and Horn (1980). Between 1961 and 1990, Aberdeen had a mean annual temperature of 12°C, with an average annual high temperature of 18°C and an average annual low temperature of 7°C. The month of July produced the warmest monthly average temperature of 28°C, with an average of 11 days reaching 32°C. Along the shores of the Chesapeake Bay, 15 to 25 days per year reached 32°C. The month of January produced the lowest average temperature of -4°C, and the highest average number of days falling below freezing (98). The city of Baltimore, located 16 km south of APG, had an extreme high temperature between 1951 and 1980 of 40.5°C in August, and a record low temperature of -21.5°C in January (Ruffner 1985, weatherpost.com). Aberdeen receives an average of 110.2 cm of precipitation per year. The wettest month was August, which received an average of 11.2 cm of precipitation. February was the driest month with an average of 6.8 cm of precipitation. The maximum monthly precipitation recorded between 1951 and 1980 in Baltimore was 46.6 cm in August. The relative humidity averages about 60% from February - April and 75% from August - October. The month of October was the only month in which no precipitation was recorded between 1951 and 1980.

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Average annual snowfall was 25.4 to 63.5 cm, occurring over 10 to 20 days per year (Ruffner 1985; Rumney 1968; weatherpost.com). The average annual wind speed was from the west at 15 kph. The windiest month was March with average wind speeds of 17.7 kph. The sunniest month was July, which receives 65% of the possible sunshine. The least amount of sunshine was received in December. There was an average of 109 clear days, 106 partly cloudy days, and 150 cloudy days per year. Thunderstorms occurred an average of 28 days per year and heavy fog an average of 27 days. The average frost penetration was ~ 25.4 cm along the coast of Maryland (Ruffner 1985, Rumney 1968, weatherpost.com).

Methods and Results

To locate occurrences of state or federal endangered or threatened vascular plant taxa at the APG site, surveys were conducted an average of twice monthly from April through October, 1998 and 1999. A voucher specimen was collected for each rare species located, and most specimens were deposited at the Smithsonian Institution's United States National Herbarium (US). Duplicates of some Cyperacea were distributed at the University of Michigan Herbarium (MICH). Lemnaceae and Alismatacea were deposited at the herbarium of the Birmingham Botanical Gardens (BBG) and the University of Alabama Herbarium (UNA), respectively. Confirmations of identifications were provided by Mark Strong (US), Anton Reznicek (MICH), Larry Davenport (Samford University) and Robert Haynes (UNA). The location of each rare plant population was marked on copies of topographic quadrangle maps for the APG, and filed with the Land Condition Trend Analysis Coordinator and the Fish and Wildlife Biologist at the APG. All nomenclature in this report follows Gleason and Cronquist (1991) except for *Eleocharis engelmannii* Steud, which follows Kartesz and Kartesz (1994) and the Maryland Department of Natural Resources (2001). Herbarium acronyms follow Holmgren et al. (1990).

Results and Discussion

Forty-two rare vascular plant species representing 31 genera in 23 families were recorded during site surveys. Although no federally "endangered" or "threatened" species were found, site surveys resulted in the first Maryland record of *Spirodela punctata* (dotted duckweed). Of the 42 species found, ten are designated as "state endangered" or "state extirpated", and one species is considered "state threatened" under Maryland's Nongame and Endangered Species Conservation Act and the Threatened and Endangered Species Regulations of the Maryland Department of Natural Resources (Code of Maryland Regulations 08.03.08). Additionally, twelve species ranked as "highly state rare" or "state rare", and 18 species ranked as "watch listed" or "status uncertain" (Maryland Department of Natural Resources 2001) were discovered.

Of the 42 rare species collected, 23 were associated with wetland habitats and 19 were found on dry to mesic soils. Within the APG, 35.7% of the species collected occurred on Carroll (Baltimore County) and Spesutie (Harford County) Islands. These Islands each supported populations of seven different rare plant species, plus one species (*Scutellaria galericulata*) ranked as "highly state rare" that occurred on both islands. The Harford County portion of APG contained populations of 30 rare species,

while the Baltimore County portion contained 7 rare species; 5 rare species were found in both counties.

The information in the annotated species list below, unless otherwise noted, is a tally of the number of records that have been processed into the Maryland Wildlife and Heritage Division's Biological and Conservation Data System (BCD) as of November 1999. Extant populations are defined by reports occurring within the last 25 years. The State rankings given are those of the Maryland Department of Natural Resources (2001). With the exception of *S. punctata,* the taxa are listed in the order of their state listed statuses as follows: endangered extirpated, endangered, threatened, highly state rare, state rare and watch list or status uncertain. The first three ranks are protected under state law (Code of Maryland Regulations 08.03.08), while the later ranks are assigned by the Maryland Natural Heritage Program, but receive no protection at present. Within each ranking, taxa are listed from least to most common according to the number of records entered into the BCD, published records and the author's field observations. Each entry contains the currently recognized genera and species names, authority, general location within APG, date the plant was found, voucher specimen information, notes on collection location within the APG and state-wide occurrence information.

Species List

No Status Because of Recent Discovery

1. *Spirodela punctata* (G. Meyer) C. Thompson (Lemnaceae)—Harford County, Woodrest Creek, 26 Jun 1999, *Steury 990626.4* (BBG and US). This is the first record of dotted duckweed from the State of Maryland (Steury 2000). It is not included in the Maryland flora by Brown and Brown (1984), and searches of local herbaria at MARY, NA and US turned up no Maryland specimens of this species. At APG it was abundant on still water near the head of Woodrest Creek, ~ 650 m due west of Brier Point. Associates at this site included greater duckweed (*Spirodela polyrhiza*) and dotted water-meal (*Wolffia papulifera*).

Endangered extirpated

2. *Lycopodium carolinianum* L. (Lycopodiaceae)—Harford County, Monks Island, 11 Sep 1999, *Steury 990911.7* (US). Confirmed under the synonym *Psendolycopodiella* (*Lycopodiella*) *caroliniana* (L.) Pichi Sermolli. This is the first known record for slender clubmoss from Harford County. No other populations are currently known from the State of Maryland. The species was last collected in Maryland in Worcester County in 1932. Titus Ulke also collected it in 1917 at a bog along the Little Paint Branch drainage that no longer exists (Strong and Simmons 2000). At Monks Island at least 1000 fruiting stems were observed along the edge of a pool of water near the northern tip of Cod Creek, just east of Towner Cove. At this site plants occurred on sandy, dry to mesic soil that was fissured into plates from seasonal drying. It was found in close association with southern clubmoss (*Lycopodiella appressa*), variable yellow-eyed grass (*Xyris difformis*) and nodding ladies' tresses (*Spiranthes cernua*).

3. *Lathyrus palustris* L. (Fabaceae)—Harford County, Spesutie Island, 7 Aug 1998, *Steury 980807.2* (US). This is the only population of marsh wild pea known from Harford

County. One other population was reported from Maryland in Montgomery County in 1983. On Spesutie Island, between a roadside and the Spesutie Narrows, an estimated 85 plants occurred along ~ 0.7 km of the edge of a moist shrub-scrub meadow. It was observed in flower with some immature fruit in August. An associate was the smooth hedge-nettle (*Stachys tenuifolia*).

4. *Apocynum sibiricum* Jacq. (Apocynaceae)—Harford County, Chilbury Point, 12 Jun 1999, *Steury 990612.2* (US). This is the first known record from Harford County. Although listed as extirpated from the state of Maryland, recent search efforts have uncovered populations of clasping-leaved dogbane at single sites in Calvert, Kent, Montgomery and Washington Counties. At Chilbury Point three plants occurred along the Bush River on a sandy beach ~ 3 m wide.

Endangered

5. *Juncus torreyi* Cov. (Juncaceae)—Baltimore County, Carroll Island, 24 Jul 1998, *Steury 980724.1* (US). Only two other known populations of Torrey's rush occur in the State of Maryland. One occurs in Prince Georges County (Davis 1995) and one at another site in Baltimore County. On Carroll Island ~ 50 plants occurred along 0.5 km of moist roadside near the APG entrance to the island.

6. *Rhynchospora globularis* (Chapman) Small var. *recognita* Gale (Cyperaceae)—Harford County, Gunpowder Neck, 24 Jul 1999, *Steury 990724.4* (US). Confirmed under the synonym *Rhynchospora recognita* (Gale) Kral. This is the only population of globular beak-rush known from Harford County. Single populations also occur in Anne Arundel, Dorchester and Worcester Counties. At Sandy Point on Gunpowder Neck > 250 plants occurred at three sites in an open, dry to mesic sandy meadow.

7. *Potamogeton foliosus* Raf. (Potamogetonaceae)—Harford County, Reardon Inlet, 24 Jul 1998, *Steury 980724.4* (US). Three other populations of leafy pondweed occur at sites in Howard, Calvert and Harford Counties. At the Edgewood facility one population covering an area of many m^2 was observed in a freshwater beaver pond at the northern tip of Reardon Inlet, in association with *Ceratophyllum echinatum*.

8. *Ceratophyllum echinatum* A. Gray (Ceratophyllaceae)—Harford County, Westwood Range (Reardon Inlet), 15 May 1998, *Steury 980515.7* (US). In Maryland additional individual prickly hornwort populations occur in four counties: Kent (Steury et al 1996), Dorchester, Queen Annes and Harford. At the Edgewood Facility a single population was found in a freshwater beaver pond near the northern tip of Reardon Inlet. At the Aberdeen Facility it occurred along Michaelsville Road, just west of the southern end of Trench Warfare Range Road, in a freshwater pond fed by Romney Creek. Both populations covered areas of at least 100 m^2.

9. *Pedicularis lanceolata* Michx. (Scrophulariaceae)—Harford County, Spesutie Island, 4 Sep 1998, *Steury 980904.3* (US). This is the only extant population of swamp lousewort known from Harford County. In Maryland this species is found at a total of

five sites in four counties: Prince Georges (Davis 1995), Baltimore (1 site), Cecil (1 site) and Garrett (2 sites). Near the center of the western side of Spesutie Island at least 25 plants were observed at the edge of a moist scrub-shrub meadow.

10. *Hottonia inflata* Elliott (Primulaceae)—Harford County, Penny Come Quick Area, 29 May 1998, *Steury 980529.2* (US). This is the only population of featherfoil known from Harford County. Other populations in Maryland occur in Carroll (3 sites), Kent (3 sites), Queen Annes (1 site) and Talbot (1 site) Counties. In the Penny Come Quick Area, just north of Ford's Farm along Romney Creek Road, an estimated 800 plants occurred in the open water areas of a swamp-loosestrife (*Decodon verticillatus*) marsh.

11. *Iris prismatica* Pursh. (Iridaceae)—Baltimore County, Carroll Island, 24 Jul 1998, *Steury 980724.13* (US); Harford County, Delph Creek, 17 October 1998, *Steury 981017.1* (US). No other populations of slender blue flag are known from Harford County, but two other populations have been reported from Baltimore County. Six other populations occur on the Eastern Shore in Kent (1 site), Wicomico (2 sites) and Worcester (3 sites) Counties. At APG at least 1000 plants occurred at six sites. In general, these sites were moist depressions in shady deciduous woods, but the largest population occurred over an area of ~ 300 m^2 on mesic sandy soils at Gunpowder Neck. Over 500 plants occurred at this site.

Threatened

12. *Lysimachia hybrida* Michx. (Primulaceae)—Harford County, Test Highway, 24 Jul 1998, *Steury 980724.6* (US). This is the only population of Mississippi Valley loosestrife known in Harford County. Nine other Maryland populations occur in Dorchester (1 site), Montgomery (3 sites), Queen Annes (1 site), Washington (2 sites) and Worcester (2 sites) Counties. The author also observed this species near Marshall Hall, Charles County. At APG ~ 50 plants occurred due west of Phillips Airfield between Test Highway and the western edge of APG. These plants were found in sandy, moist depressions of a 2.5 km^2 open shrub meadow.

Highly state rare

13. *Potamogeton pusillus* L. (Potamogetonaceae)—Baltimore County, Gunpowder River, 22 July 1998, *Steury 980722.3* (US). This is the only population of slender pondweed known from Baltimore County. Populations are reported from two other Maryland counties, Charles (1 site) and Queen Annes (1 site). According to BCD entries, prior to 1969 at least 12 populations were known in five other Maryland Counties. Orth et al. (1997) also recorded the species from at least two other Maryland counties. At APG it was found at three brackish water sites located in bays at the confluence of Saltpeter and Dundee Creeks, just north of Carroll Island and south of Graces Quarters, along the Gunpowder River. The largest population occurred sporadically over a 400 m^2 area and was rooted under water ~ 2.5 m deep.

14. *Scutellaria galericulata* L. (Lamiaceae)—Baltimore County, Carroll Island, 24 Jul 1998, *Steury 980724.21* (US); Harford County, Spesutie Island, 7 Aug 1998, *Steury 980807.7* (US). These are the first known records for Harford and Baltimore Counties. Populations of marsh-skullcap in Maryland are known from a total of four sites in Howard, Montgomery, Calvert (Steury 1997) and Kent (Steury et al. 1996) Counties. At APG the largest population, which measured three m^2 in area, occurred along the edge of a common reed (*Phragmites australis*) marsh near the entrance to Carroll Island. On the west side of Spesutie Island five plants were observed in a similar habitat.

15. *Carex straminea* Willd. (Cyperaceae)—Harford County, Romney Creek Road, 15 May 1998, *Steury 980515.4* (US). The rank of this species was upgraded in 2001 from "watch list" to "highly state rare" due to the paucity of records for this species statewide (Maryland Department of Natural Resources 1994; 2001). An estimated 25 tufts of straw colored sedge occurred at the northern end of Romney Creek Road, along the edge of a *Decodon verticillatus* marsh.

16. *Gymnocladus dioica* (L.) K. Koch (Caesalpiniaceae)—Harford County, Spesutie Island, 20 Jul 1998, *Steury 980720.4* (US). The population of Kentucky coffee-trees located during this survey is most likely a horticultural remnant persisting at an abandoned home site on Spesutie Island, just west of Sandy Point. The tree is well established and spreading at this site, where at least 25 trees of various age groups occurred. Only two natural populations in Baltimore and Washington Counties are cited in the BCD. Early settlers used the roasted seeds of this tree as a caffeine-free coffee substitute.

State rare

17. *Pycnanthemum virginianum* (L.) Durand & B.D. Jackson (Lamiaceae)—Harford County, Spesutie Island, 7 Aug 1998, *Steury 980807.4* (US). This is the only population of Virginia mountain mint known from Harford County. Seven populations occur in three other Maryland counties: Allegany (3 sites), Baltimore (2 sites) and Washington (2 sites). The author also observed this species at one site in Prince Georges County in 2000. On western Spesutie Island this species was very common in open shrub-scrub meadows and along roadsides, where it occurred on dry to mesic, sandy loam. The total number of plants was estimated to be > 1000. Gray mountain mint (*Pycnanthemum muticum*) was a common associate.

18. *Potamogeton perfoliatus* L. (Potamogetonaceae)—Baltimore County, Gunpowder River, 22 Jul 1998, *Steury 980722.1* (US). Possibly a declining species in Maryland, no other populations of redhead-grass are reported from the State since 1968. Prior to 1968 BCD entries indicate at least 28 populations in seven Maryland Counties. However, Orth et al. (1997) does report this species from at least four Maryland counties. Two populations, neither larger than four m^2, were observed in brackish water of the Gunpowder River at the mouth of Saltpeter Creek and just off White Oak Point of Carroll Island.

19. *Sagittaria spatulata* (J.G. Smith) Buchenau (Alismataceae)—Harford County, Monks Creek, 2 Oct 1998, *Steury 981002.1* (UNA and US). Confirmed under the synonym *Sagittaria montevidensis* Chamisso & Schlechtendal subsp. *spongiosa* (G. Engelmann). In Maryland 18 populations of tidal sagittaria are reported from 8 counties. It is most common in Cecil County (8 sites), but is also reported from Anne Arundel (1 site), Charles (1 site), Dorchester (2 sites), Kent (2 sites), Prince Georges (1 site) and Wicomico (2 sites) Counties, and from one other site in Harford County. At two sites near the mouth of Monks Creek, 34 plants occurred along muddy shorelines that were exposed at low tide. Salinity at these sites was 2.3 ppt in October. In addition, ~ 50 plants occurred in similar habitat at one site on Mosquito Creek.

20. *Wolffia papulifera* C. Thompson (Lemnaceae)—Harford County, Romney Creek pond, 29 May 1998, *Steury 980529.6* (UNA and US). Confirmed under the synonym *Wolffia brasiliensis* Weddell. This is the first known record from Harford County. The only other record of this species in Maryland in the BCD is from Worcester County in 1971. However, the author also collected this species in a small pond along the Potomac River in northern Charles County in 1999. The paucity of records for this species is more likely due to its cryptic nature and tiny size than its actual statewide rarity. At APG this species was found at four sites on still freshwater creeks and ponds including: a pond fed by Romney Creek along Michaelsville Road west of the southern end of Trench Warfare Range Road; a pond along Maryland Boulevard just north of Ruggles Golf Course; a pond at Briery Point on Gunpowder Neck; and along the head of Woodrest Creek.

21. *Eleocharis rostellata* (Torr.) Torr. (Cyperaceae)—Baltimore County, Carroll Island, 24 Jul 1999, *Steury 980724.18* (MICH and US). This is the only known population of this spike rush in Baltimore County, and the northern most population in the State of Maryland. Other populations are known from single sites in Anne Arundel and Wicomico Counties, and from 11 sites in Worcester County. In an oligohaline marsh on Carroll Island, northwest of Hawthorn Cove, at least 100 tufts occurred over an area of ~4225 m^2.

22. *Bidens coronata* (L.) Britton (Asteraceae)—Baltimore County, Carroll Island, 18 Sep 1998, *Steury 980918.2* (US); Harford County, Romney Creek, 11 Sept 1999, *Steury 990911.5* (US). This is the first known record of northern tickseed sunflower from Harford County. Other populations occur at two sites in Somerset County, single sites in Charles, Dorchester, Talbot and Wicomico Counties, and one other site in Baltimore County. A total of at least 65 plants occurred in an oligohaline marsh, and along moist roadside just north of Hawthorn Cove on Carroll Island. In Harford County at least 95 plants occurred in three cattail marshes at Towner Cove, Redman Cove and Romney Creek.

23. *Myosotis macrosperma* Engelm. (Boraginaceae)—Harford County, Old Womans Gut, 26 Jun 1999, *Steury 990626.3* (US). This is the first known record of bigseed forget-me-not from Harford County. Sixteen other populations are known to occur

in four Maryland Counties: Calvert (6 sites), Charles (7 sites), Prince Georges (2 sites) and St. Marys (1 site). At APG, ~ 100 m northwest of the head of Old Womans Gut, one population of eight plants was observed in a young, open, mesic deciduous woodland with scattered moist depressions.

24. *Juglans cinerea* L. (Juglandaceae)—Harford County, Redman Cove area, 21 Aug 1998, *Steury 980821.4* (US). The single population of Butternut trees found during this survey is likely a horticultural remnant persisting from abandoned home sites that once occurred in the area. A well established associate at this site was the flying dragon (*Poncyrus trifolia*), a species often planted in hedgerows. In Maryland the BCD lists ten native populations of butternut from a total of six counties: Allegany (2 sites), Dorchester (2 sites), Frederick (1 site), Garrett (2 sites) and Washington (2 sites). The author has also observed two large fruiting specimens of this tree growing in Fort Washington National Park, Prince Georges County. Redman (1999) reported a few immature trees from Oregon Ridge Park, Baltimore County. At APG seven fruiting trees were observed at an old home site just southeast of Redman Cove, and southwest of the intersection of Abby Point and Cod Creek Roads. The largest tree measured 107.7 cm dbh.

Watch list or status uncertain

25. *Sagittaria subulata* (L.) Buchenau (Alismataceae)—Harford County, Mosquito Creek, 10 Jul 1999, *Steury 990710.2* (UNA and US). Approximately 575 m due west of Black Point an estimated 5000 plants of Hudson sagittaria occurred at one site along a marsh edge on tidal muddy peat.

26. *Asclepias purpurascens* L. (Asclepiadaceae)—Harford County, Michaelsville Road, 12 Jun 1998, *Steury 980612.1* (US). Six plants of purple milkweed in full bloom occurred in a dry meadow on the east side of Michaelsville Road, due west of the northern end of Trench Warfare Range Road. An additional 24 plants were observed in a dry, open shrubby meadow along an unnamed stone road at Mosquito Creek, ~ 1 km south of Trench Warfare Range Road.

27. *Bidens bidentoides* (Nutt.) Britton (Asteraceae)—Harford County, Spesutie Narrows, 4 Sep 1998, *Steury 980904.1* (US). Although ranked as a "watch list species", the Maryland Natural Heritage Program tracks this species because of the global significance of Maryland populations. Globally, southern estuarine beggar-tick is known to occur only along the East Coast of the United States between New York and Maryland. In Maryland, populations are known from Cecil (30 sites) and Harford (2 sites) Counties. At the northern end of the Spesutie Island Narrows, on a mix of tidal gravel, sand and mud, 13 plants occurred at two sites ~ 25 m apart. At the Edgewood facility > 125 plants were observed on tidal sand along Lauderick Creek, at Skippers Point.

28. *Bidens discoidea* (T. & G.) Britton (Asteraceae)—Harford County, Penny Come Quick Area, 4 Sep 1998, *Steury 980904.2* (US). This is the only population of few-bracted beggar-tick known from Harford County. Seventeen other populations occur in the state including: single populations in Queen Annes and Talbot Counties; two popu-

lations in each of Anne Arundel, Carroll, Dorchester, Kent and Prince Georges Counties; and three populations in Worcester County. In addition, Steury (1997; 1998) reported the species from two sites in Calvert County. Over a distance of ~ 1 km in the Penny Come Quick Area, an estimated 50 plants occurred in a *Decodon verticillatus* marsh along Romney Creek Road, north of Ford's Farm.

29. *Cirsium horridulum* Michx. (Asteraceae)—Baltimore County, Carroll Island, 12 Jun 1999, *DeRoia* and *Steury 990612.1* (US). In a dry, sandy, gama grass (*Tripsacum dactyloides*) meadow on Carroll Island, an estimated 35 plants of yellow thistle occurred over an area of ~ 1600 m^2.

30. *Cirsium muticum* Michx. (Asteraceae)—Harford County, Spesutie Island, 21 Aug 1998, *Steury 980821.2* (US). At least five populations of swamp thistle occurred on Spesutie Island, generally in full sun along marsh edges, or in sandy, moist, shrubby meadows. The largest population contained < 21 plants.

31. *Myosotis verna* Nutt. (Boraginaceae)—Harford County, Chilbury Point, 8 May 1999, *Steury 990508.2* (US). Approximately 20 spring forget-me-nots were found at Chilbury Point on very dry soils, and in association with frostweed (*Helianthemum canadense*). An additional 30 plants were found on moist to mesic soils along Mosquito Creek, ~ 1 km south of Trench Warfare Range Road. Associates at this site included a spike rush (*Eleocharis tenuis* var. *pseudoptera*), marsh bellflower (*Campanula aparinoides*), soapwort gentian (*Gentian saponaria*), tall flat-topped white aster (*Aster umbellatus*) and round-headed bush-clover (*Lespedeza capitata*).

32. *Carex complanata* Torr. & Hook (Cyperaceae)—Harford County, Michaelsville Road, 29 May 1998, *Steury 980529.8* (US). A total of 40 tufts of flattened sedge occurred at three sites in open, grassy, roadside meadows along Romney Creek, Michaelsville and Briar Point Roads.

33. *Carex grayi* Carey (Cyperaceae)—Harford County, Spesutie Island, 12 Jun 1998, *Steury 980612.2* (US). One patch of Gray's sedge occurred along the shoreline at the northern end of Spesutie Narrows. A second patch was found along Swan Creek at Palisades Park. Neither population was larger than one m^2.

34. *Carex typhina* Michx. (Cyperaceae)—Harford County, Mosquito Creek, 26 Jun 1999, *Steury 990626.1* (US). This is the first known record of cattail sedge from Harford County. Other Maryland Counties with populations of this sedge are Carroll (2 sites), Charles (1 site) and Prince Georges (1 site). Near a northern tributary of Mosquito Creek, a single tuft with many fruiting culms was observed in young, open, deciduous woodland with moist depressions. In a similar but less wooded habitat, a single tuft was also found south of Mosquito Creek, ~ 100 m northwest of the head of Old Womans Gut.

35. *Cyperus lancastriensis* Porter (Cyperaceae)—Harford County, Spesutie Island, 20 Jul 1998, *Steury 980720.3* (US). Fifteen plants of Lancaster's Sedge occurred at two dry roadside sites in the southeast corner of Spesutie Island.

36. *Eleocharis engelmannii* Steud. (Cyperaceae)—Harford County, Test Track Road, 20 Jul 1998, *Steury 980720.2* (US). A single tuft of Engelmann's spikerush, containing ~ 40 fruiting stems, was observed at the edge of a sandy pool, just west of Test Track Road.

37. *Scirpus pendulus* Muhl. (Cyperaceae)—Baltimore County, Graces Quarters, 20 Jul 1998, *Steury 980720.7* (US); Harford County, Old Baltimore Road, 24 Jul 1999, *Steury 990724.3* (US). Six drooping bulrushes occurred in a mesic roadside meadow near the APG entrance to Graces Quarters. Another 16 plants occurred at the intersection of Old Baltimore and A-A5 Roads.

38. *Castanea dentata* (Marshall) Borkh. (Fagaceae)—Harford County, Skipper Point, 22 May 1999, *Steury 990522.1* (US). Three American chestnut trees occurred on dry sandy loam at Skippers Point, along the edge of Lauderick Creek. The largest tree was ~ 9 m tall.

39. *Sabatia dodecandra* (L.) BSP (Gentianaceae)—Baltimore County, Carroll Island, 24 Jul 1998, *Steury 980724.15* (US); Harford County, Gunpowder Neck, 7 August 1999, *Steury 990807.4* (US). The Carroll Island population of perennial sea-pink contained at least 35 plants, and occurred at the edge of a roadside marsh. In addition, ~ 200 plants were found in a mesic meadow on Gunpowder Neck, ~ 650 m due west of Leges Point.

40. *Najas guadelupensis* (Sprengel) Magnus (Najadaceae)—Baltimore County, Gunpowder River, 22 Jul 1998, *Steury 980722.2* (US). At least two populations of southern water-nymph, often rooted under water 1-2 m deep, occurred at the confluence of Dundee and Saltpeter Creeks, and the Gunpowder River. The largest population occurred in a large cove at the southern end of Graces Quarters, and was sporadically distributed over ~ 300 m^2. A smaller population occurred just off of Bengies Point.

41. *Ranunculus pusillus* Poiret (Ranunculaceae)—Baltimore County, Carroll Island, 8 Apr 1998, *Steury 980408.1* (US); Harford County, Michaelsville Road, 29 May 1998, *Steury 980529.3* (US). Low spearwort was observed in a small roadside depression on Carroll Island, just west of White Oak Point. Additionally, an estimated 1000 plants occurred in wet roadside ditches and young moist woodlands along Michaelsville Road.

42. *Hedyotis uniflora* (L.) Lam. (Rubiaceae)—Harford County, Romney Creek, 11 Sep 1999, *Steury 990911.1* (US). This is the first known record of clustered bluets from Harford County. In Maryland seventeen other populations of this species occur in eight Counties: Anne Arundel (1 site), Carroll (3 sites), Dorchester (1 site), Kent (1 site),

Somerset (1 site), Queen Annes (1 site), Wicomico (2 sites) and Worcester (5 sites). In 2000 the author also found a large population of this species in a roadside ditch near Marshall Hall, Charles County. At APG it was found at one site along the west side of Romney Creek Road, ~ 250 m south of the intersection of Romney Creek and A-A5 Roads. At this site an estimated 1000 plants occurred on sandy loam in the bottom of an ~ 800 m^2, drought-drawn-down pool. Associates at this site included autumn fimbristylis (*Fimbristylis autumnalis*), *Xyris difformis* and tooth-cup (*Rotala ramosior*).

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Literature Cited

Brown, M.L., and R.G. Brown. 1984. *Herbaceous plants of Maryland.* Port City Press, Baltimore.

Davis, C.A. 1995. *Survey for Rare, Threatened and Endangered Plants in the Fee Simple Lands of Piscataway Park, Charles and Prince Georges Counties, Maryland.* National Park Service, Washington, DC. NACE-4-0A01.

Gleason, H.A., and A. Cronquist. 1991. *Manual of the Vascular Plants of the Northeastern United States and Adjacent Canada.* New York Botanical Garden, Bronx.

Holmgren, P.K., N.H. Holmgren, and L.C. Barnett. 1990. *Index Herbariorum Part I: The Herbaria of the World.* New York Botanical Garden, Bronx.

Hunt, C.B. 1974. *Natural Regions of the United States and Canada.* W.H. Freeman and Company, San Francisco.

Kartesz, J.T., and R. Kartesz. 1994. *A Synonymized Checklist of the Vascular Flora of the United States, Canada and Greenland.* Timber Press, Portland, Oregon.

Maryland Department of Natural Resources. 1994. *Rare, Threatened and Endangered Plants of Maryland.* Maryland Natural Heritage Program, Annapolis.

Maryland Department of Natural Resources. 2001. *Rare, Threatened and Endangered Plants of Maryland.* Maryland Wildlife and Heritage Division, Annapolis.

Orth, R.J., J.F. Nowak, D.J. Wilcox, J.R. Whiting, and L.S. Nagey. 1997. *1996 Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay.* College of William and Mary, Cloucester Point, Virginia.

Ranson, R.H., Jr. and M. Levan. 1998. *Aberdeen Proving Grounds: Soil Survey Report.* Natural Resources Conservation Service, United States Department of Agriculture, Beltsville, Maryland.

Redman, D.E. 1999. An annotated checklist of the vascular flora of Oregon Ridge Park, Baltimore County, Maryland. *The Maryland Naturalist* 43:1-31.

Ruffner, J.A. 1985. *Climates of the States. Volume I.* Gale Research Company, Detroit, Michigan.

Rumney, G.R. 1968. *Climatology and the World's Climates*. The MacMillan Company, New York.

Steury, B.W. 1997. Survey for endangered, threatened and rare vascular plants in Cove Point Marsh, Calvert County, Maryland. *The Maryland Naturalist* 41:89-96.

Steury, B.W. 1998. Floristic survey of Battle Creek Cypress Swamp Sanctuary, Calvert County, Maryland. *The Maryland Naturalist* 42:24-28.

Steury, B.W. 2000. Noteworthy collections from Maryland. *Castanea* 65:228-231.

Steury, B.W., R.W. Tyndall, and G. Cooley. 1996. Noteworthy collections from Maryland. *Castanea* 61:392-396.

Strong, M.T., and R.H. Simmons. 2000. Noteworthy collections from Maryland. *Castanea* 65:297-299.

Trewartha, G.T., and L.H. Horn. 1980. *An Introduction to Climate*. McGraw Hill Book Company, New York.

Reproduction in West Virginia Populations of the Southern Two-lined Salamander (*Eurycea cirrigera*)

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Abstract.—We describe reproduction in West Virginia populations of the southern two-lined salamander (*Eurycea cirrigera*) and provide insights into the behavioral ecology of this wide-ranging urodele. The first signs of reproduction are evident well before the arrival of Spring. Sexually mature adults inhabit the cold, rocky streams of southwestern West Virginia in early February. Females are known by the presence of large öocytes visible through the body wall and males by their extremely swollen heads. Breeding occurs in the stream during late March and is marked by the presence of gravid females with sperm caps in their posterior cloacae. Eggs are deposited from mid-March through early April on the underside of flat rocks in cool, shallow, and swiftly flowing streams. Females guard their nests against potential predators, including other two-lined salamanders. Hatchlings emerge as miniature adults with gills after several months of development.

Introduction

Traditional conservation programs emphasize the protection of species that are imminently threatened by extinction (Dodd and Franz 1993; Lovich and Gibbons 1997). Most funding and research effort is directed at rare species, while the biological status of common species is frequently overlooked (Dodd and Franz 1993). Dramatic and unexpected declines have occurred, however, in many populations of seemingly common amphibian and reptile species, including tortoises (Dodd and Franz 1993), freshwater turtles (Dodd and Franz 1993), and frogs (Blaustein and Wake 1990; Wyman 1990). These examples suggest we can no longer afford to ignore common species. A proactive alternative is the development of monitoring protocols that include rare and common species alike (Dodd and Franz 1993). With such protocols in place, declines in seemingly common species can be identified before the slide towards extinction is irreversible.

Members of the two-lined salamander complex (*Eurycea bislineata*, *E. cirrigera*, and *E. wilderae*) are found throughout eastern North America and are generally perceived as common. Adults are typically found under rocks and logs along streams, springs, and seeps. *Eurycea cirrigera*, the southern two-lined salamander, occurs from southern Virginia, west to eastern Illinois, and south to northern Florida and eastern Louisiana (Mittleman 1966; Conant and Collins 1998; Petranka 1998). In West Virginia, *E. cirrigera* occupies the southwestern two-thirds of the state in the Allegheny Plateau physiographic province (Jacobs 1987; Brophy 1995; Conant and Collins 1998). Because it is such a wide-ranging species, geographic variation in life history traits is common (Petranka 1998). Unfortunately, life histories of many West Virginia salamanders are

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poorly documented. In this paper we describe reproduction in West Virginia populations of *E. cirrigera* (corroborating Green and Pauley 1987) and provide insights into the behavioral ecology of this wide-ranging urodele.

Methods and Materials

During 1994 and 1995, various aspects of reproduction were examined in two populations of *E. cirrigera* located at Fitzpatrick's Branch (a tributary to Hisey Fork) in Huntington, Cabell County, West Virginia, and an unnamed tributary to Beech Fork near Bowen, Wayne County, West Virginia. Both are small intermittent streams flowing through *Quercus* dominated, mixed mesophytic forests. In addition to populations of *E. cirrigera*, each supports a population of northern dusky salamanders (*Desmognathus f. fuscus*) and Kentucky spring salamanders (*Gyrinophilus porphyriticus duryi*).

Sexually mature adults and egg masses were located by turning rocks and logs in and along the two streams. Sex and reproductive condition were determined for each adult captured, and snout-vent length (SVL), head width (at broadest point), and head length (tip of snout to gular fold along ventral midline) were measured to the nearest 0.1 mm using dial calipers. Water temperature (°C) was also recorded for each adult captured in the aquatic habitat. In addition, we examined each clutch, counted the number of eggs, and measured the maximum length and width of the egg mass to the nearest 0.1 mm. We also measured the diameter of five eggs (0.1 mm) and recorded the sex and size of adults found near each mass. The following microhabitat characteristics were measured for each nest site and pair of breeding adults: rock size (surface area=SA; thickness=THK in cm); distance to nearest stream edge (cm); water temperature (°C); water depth (cm); and stream flow (m/s).

One egg mass, collected on 31 March 1994 from the tributary to Beech Fork, was taken to the laboratory at Marshall University and maintained in aerated streamwater. Water temperatures ranged from 13-21°C because the egg mass was kept in a poorly heated laboratory within five meters of an old window. The egg mass was monitored and individuals were staged according to Harrison (1969) on four separate dates. Upon hatching, salamanders were killed in chloretone, fixed in 10% buffered formalin, and stored in 70% ethanol. The SVL of hatchlings was measured to the nearest 0.1 mm using a dissecting microscope and ocular micrometer. Data are reported as mean values ± 1 SD (minimum-maximum).

Results and Discussion

Sexually Mature Adults

Gravid *E. cirrigera* females (N=7) were found in the tributary to Beech Fork between 12 February and 9 April 1994 at water temperatures of 4.0-12.5°C. Females were identified by the presence of large öocytes visible through the body wall (Stewart 1956; Bruce 1988), and the SVL of seven gravid females averaged 43.2 ± 1.9 (40.9-45.8) mm. Published SVL measurements for gravid two-lined salamanders range between 31.0 to 50.0 mm (Wood and McCutcheon 1954; Stewart 1956; Bruce 1988; Bahret 1996).

Sexually mature *E. cirrigera* males (N=30) were found in the tributary to Beech Fork between 25 February and 17 April 1994 at water temperatures of 6.0-14.0°C. They

possessed secondary sexual characteristics including swollen heads (Sever 1979). The SVL of 30 mature males averaged 42.6 ± 2.4 (38.4-49.5) mm and was similar to the published values (30.2-45.3 mm) of Stewart (1956) and Bruce (1988). The average head width to length ratio (HW/HL) for mature males in our study was 0.94 ± 0.05 (n=28), which was significantly greater (*t*-test, $t = 5.92$, df = 32, $P < 0.001$) than that of mature females (HW/HL = 0.80 ± 0.06, n = 6). Male two-lined salamanders from portions of Ohio, Kentucky, and West Virginia lack cirri but develop an enlarged temporal musculature during the breeding season, representing an extreme case of polymorphism in this species complex (Sever 1972, 1979).

Breeding

On 31 March 1994, a mature male and gravid female *E. cirrigera* were found breeding under a flat rock in the tributary to Beech Fork. The male, 45.1 mm SVL, had an enlarged temporal musculature (HW/HL=1.02) as described above. The gravid female, 43.7 mm SVL, had a sperm cap in her posterior cloaca. The rock (SA=238 cm^2, THK=5 cm) sheltering these salamanders was located in a small riffle (stream flow=0.37 ± 0.04 m/s), 55 cm from the nearest stream edge. Water temperature and depth at the capture point were 7.0°C and 9.0 cm, respectively. Two-lined salamanders breed from September through May (Noble and Weber 1929; Weichert 1945; Stewart 1958; Sever 1979), but patterns in local populations depend on the severity of winter weather and other environmental factors (Petranka 1998).

Egg Masses

Between mid-March and early April 1994 and 1995, six egg masses deposited by *E. cirrigera* (Table 1) were discovered in Fitzpatrick's Branch and the tributary to Beech Fork. All egg masses were oval, attached to the underside of rocks within the streams, and in the early stages of development. Masses were found between 21 March and 8 April in both years. Mean clutch size was 47.2 ± 8.33 and mean egg diameter was 3.11 ±

Table 1. Data for *Eurycea cirrigera* egg masses discovered at the tributary to Beech Fork (BF) and Fitzpatrick's Branch (FB) in southwestern West Virginia. Values for egg diameter are means ± 1 SD and n=5 in all cases.

Mass #	Date	Clutch Size	Mass Size (mm)	Egg Diameter (mm)
BF-1	31 Mar 1994	59	46.4 x 39.1	3.52 ± 0.13
BF-2	6 Apr 1994	42	41.0 x 30.8	3.04 ± 0.22
FB-1	21 Mar 1995	43	40.0 x 35.0	3.00 ± 0.00
FB-2	21 Mar 1995	51	50.0 x 30.0	3.00 ± 0.00
FB-3	8 Apr 1995	36	58.0 x 50.0	3.10 ± 0.22
FB-4	8 Apr 1995	52	50.0 x 30.0	2.90 ± 0.22
Mean ± 1SD		47.2 ± 8.33	47.57 ± 6.67 x 35.82 ± 7.82	3.11 ± 0.27

0.27 mm. Mean length and width of the six masses were 47.57 ± 6.67 mm and 35.82 ± 7.82 mm, respectively. These results correspond well with published reports of egg-laying in the two-lined salamander complex (Table 2).

A single adult was found near four of the six egg masses. Two were spent females (BF-1 and BF-2; SVL of BF-2 female=41.9 mm), one a gravid female (FB-2; SVL=45.0 mm), and one a mature male (FB-1). The spent females were probably guarding their nests, which is a common practice in this species complex (Wood 1949, 1953; Richmond 1945; Stewart 1956; Baumann and Huels 1982; Bruce 1982; Marshall 1996). Both streams in our study contain numerous potential egg predators including crayfish (*Cambarus* sp.), dusky salamanders (*D. f. fuscus*), and spring salamanders (*G. porphyriticus duryi*). The presence of *E. cirrigera* females may deter some of these predators (Stewart 1956; Baumann and Huels 1982). The gravid female with egg mass FB-2 (Table 1) may have been attempting to oviposit on that same rock (Table 3), as the complements of several females are frequently found in the same nest (Bishop 1941; Weber 1928; Wood 1953; Wood and McCutcheon 1954; Baumann and Huels 1982; Green and Pauley 1987). Alternatively, both the gravid female and mature male may have been attempting öophagy (D. C. Forester, pers. comm.).

Nest Site Microhabitat

Microhabitat characteristics for each nest site are presented in Table 3. Nests were found in cool, shallow, swiftly flowing stream riffles. Mean water temperature was 9.4 ± 2.1° C. Mean water depth was 6.36 ± 3.73 cm. Mean stream flow was 0.24 ± 0.08 m/s. Nests were found at both the edge and center of the streams. Mean distance to the nearest stream edge was 28.83 ± 19.58 cm. Two-lined salamanders prefer the underside of flat rocks for nesting (Wilder 1899; Noble and Richards 1932; Baumann and Huels 1982), and these are often a limiting factor in reproduction (Stewart 1968). Mean surface area and thickness of the rocks utilized in our study were 173.08 ± 33.66 cm^2 and 6.38 ± 4.82 cm, respectively. Our data on nest site microhabitats corroborates the information presented by other authors (Table 4).

Development and Hatching

The egg mass reared in the laboratory (BF-1) was deposited on 29 March 1994 and completed development on 25 April 1994. On 1 April 1994, three days from deposition, the eggs were between Harrison (1969) stages 1 and 12. On 12 April 1994, 14 days from deposition, the eggs were between Harrison (1969) stages 29 and 30. On 21 April 1994, 23 days from deposition, the eggs were between Harrison (1969) stages 42 and 45. At this point, some of the eggs had hatched and by 25 April 1994 all eggs were hatched. All eggs hatched between Harrison (1969) stages 42 and 45. The development period for two-lined salamanders ranges from 1-3 months in nature (Wilder 1924; Bishop 1941; Duellman and Wood 1954; Johnson and Goldberg 1975; Green and Pauley 1987; Bruce 1982, 1985, 1988). The egg mass in our study completed development in 27 days at water temperatures of 13-21° C. Stream temperatures were much lower during this period (7-15°C), so development in the field would likely have taken longer (Bishop 1941; Petranka 1998).

Forty-nine (83%) of the original 59 laboratory reared eggs reached the hatching stage. The condition of two of the 49 hatchlings did not allow measurement of SVL; the

Table 2. Published reports of oviposition dates and egg mass characteristics for members of the *Eurycea bislineata* (Two-lined Salamander) complex. Numbers are means unless otherwise indicated. Single observations are marked with an asterisks and numbers in parentheses are ranges. A dash indicates no data reported.

Species	Locality	Oviposition Period	Clutch Size	Mass Size (mm)	Egg Diameter (mm)	Reference
cirrigera	southern WV	mid Mar-mid Apr	40*	–	–	Green and Pauley 1987
	SE OH	3-17 May	39 (15-110)	50 x 32	2.5	Baumann and Huels 1982
	SE OH	–	36*	–	–	Siebert and Brandon 1960
	Cincinatti, OH	late Mar-mid Apr	–	–	–	Weichert 1945
	James City Co., VA	23 Jan-16 Apr	52 (18-96)	–	–	Wood and McCutcheon 1954
	New Kent Co., VA	21 Apr	(42-45)	–	2	Richmond 1945
	Lafayette Co., MS	Apr-May	53	–	–	Marshall 1996
	Athens, GA	–	36*	–	–	Martof 1955
wilderae	SW NC	Feb-May	23*	–	–	Bruce 1982, 1985, 1988
	Mt. Mitchell, NC	4 May	87*	–	2.5	Wood 1949
bislineata	Tucker Co., WV	early Apr	–	–	–	Marcum 1994
	NY	–	25 (3-41)	–	2	Noble and Richards 1932
	NY	11 Apr-25 Jun	(18-68)	(76 x 152)	(2.5-3.0)	Bishop 1941
	NY	20 Apr-21 May	34 (12-60)	–	(1.9-2.1)	Stewart 1956, 1968
	Shawangunk Mts., NY	–	15 (5-28)	–	–	Bahret 1996
	western MA	27 May-12 Jun	(30-50)	–	–	Wilder 1899
	Sunderland, MA	May-early Jun	18 (12-36)	–	–	Wilder 1924
	ME	20 May	40*	–	–	Verill 1863

Table 3. Microhabitat characteristics of *Eurycea cirrigera* nest sites from southwestern West Virginia. Values for water depth and stream flow are means ± 1 SD (n=3).

Mass #	Rock SA (cm^2)	Rock THK (cm)	Distance to Edge (cm)	Water Depth (cm)	Water Temp (°C)	Stream Flow (m/s)
BF-1	144.5	16.0	56.0	5.0 ± 0.00	7.0	0.37 ± 0.01
BF-2	165.0	6.0	50.0	13.0 ± 1.73	10.0	0.17 ± 0.02
FB-1	209.0	5.0	10.0	5.33 ± 2.31	8.0	0.22 ± 0.04
FB-2	156.0	4.0	20.0	6.0 ± 0.87	8.0	0.26 ± 0.06
FB-3	221.0	3.0	12.0	2.33 ± 0.29	12.5	0.23 ± 0.00
FB-4	143.0	4.2	25.0	5.58 ± 0.95	11.0	0.16 ± 0.03
Mean ± 1 SD	173.08 ± 33.66	6.38 ± 4.82	28.83 ± 19.58	6.36 ± 3.73	9.42 ± 2.11	0.24 ± 0.08

Table 4. Published reports of nest site microhabitat characteristics for members of the *Eurycea bislineata* (Two-lined Salamander) complex. Numbers are means unless otherwise indicated. Single observations are marked with an asterisks and numbers in parentheses are ranges. A dash indicates no data reported.

Species	Locality	Rock Size (cm^2) x Thickness (cm)	Distance to Edge of stream (m)	Water Depth (cm)	Water Temperature (°C)	Stream Flow (m/s)	Reference
cirrigera	SE OH	(132-1260)	–	–	–	–	Baumann and Huels 1982
	SE OH	929*	–	–	–	–	Siebert and Brandon 1960
	New Kent Co., VA	–	–	(2.5-7.6)	–	–	Richmond 1945
	Lafayette Co., MS	–	–	20*	(15-18)	(2.4-16.8)	Marshall 1996
wilderae	SW NC	2100x30*	4*	24*	–	–	Bruce 1982
bislineata	Essex Co., NY	329x10*	–	–	–	–	Weber 1928
	NY	–	–	(20.3-30.5)	–	–	Bishop 1941
	Ithaca, NY	330x9	(0.3-1.5)	(5.1-25.4)	(9-26)	–	Stewart 1956
	Shawangunk Mts., NY	–	32 (21-50)	1130 (900-1350)	–	–	Bahret 1996

remaining 47 hatchlings averaged 7.73 ± 0.23 (7.1-8.2) mm. Hatchling two-lined salamanders from other portions of the species range measure 6-11 mm SVL (Duellman and Wood 1954; Johnson and Goldberg 1975; Bruce 1982; Marcum 1994; Bahret 1996).

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Literature Cited

Bahret, R. 1996. Ecology of lake dwelling *Eurycea bislineata* in the Shawangunk Mountains, New York. *Journal of Herpetology* 30:399-401.

Baumann, W. L., and M. Huels. 1982. Nests of the two-lined salamander, *Eurycea bislineata*. *Journal of Herpetology* 16:81-83.

Bishop, S. C. 1941. The salamanders of New York. *New York State Museum Bulletin* 324:1-365.

Blaustein, A. R., and D. B. Wake. 1990. Declining amphibian populations: A global phenomenon? *Trends Ecology and Evolution* 5:203-204.

Brophy, T. R. 1995. Natural history, ecology, and distribution of *Eurycea cirrigera* in West Virginia. M.S. Thesis, Marshall University, Huntington, WV.

Bruce, R. C. 1982. Egg-laying, larval periods and metamorphosis of *Eurycea bislineata* and *E. junaluska* at Santeetlah Creek, North Carolina. *Copeia* 1982:755-762.

_____. 1985. Larval period and metamorphosis in the salamander *Eurycea bislineata*. *Herpetologica* 41:19-28.

_____. 1988. An ecological life table for the salamander *Eurycea wilderae*. *Copeia* 1988:15-26.

Conant, R., and J. T. Collins. 1998. *A Field Guide to Reptiles and Amphibians of Eastern and Central North America*. Houghton Mifflin Co., Boston, MA.

Dodd, C. K., Jr., and R. Franz. 1993. The need for status information on common herpetofaunal species. *Herpetological Review* 24:47-50.

Duellman, W. E., and J. T. Wood. 1954. Size and growth of the two-lined salamander, *Eurycea bislineata rivicola*. *Copeia* 1954:92-96.

Green, N. B., and T. K. Pauley. 1987. *Amphibians and Reptiles in West Virginia*. University of Pittsburgh Press, Pittsburgh, PA.

Harrison, R. G. 1969. Harrison stages and description of the normal development of the spotted salamander, *Ambystoma punctatum* (Linn.). Pages 44-46 *in* R. G. Harrison (ed.). *Organization and Development of the Embryo*, Yale University Press, New Haven, CT.

Jacobs, J. F. 1987. A preliminary investigation of geographic genetic variation and systematics of the two-lined salamander, *Eurycea bislineata* (Green). *Herpetologica* 43:423-446.

Johnson, J. E., and A. S. Goldberg. 1975. Movement of larval two lined salamanders (*Eurycea bislineata*) in the Mill River, Massachusetts. *Copeia* 1975:588-589.

Lovich, J. E., and J. W. Gibbons. 1997. Conservation of covert species: Protecting species we don't even know. Pages 426-429 *in* J. Van Abbema (ed.). *Proceedings: Conservation, Restoration, and Management of Tortoises and Turtles—An International Conference*. New York Turtle and Tortoise Society, New York, NY.

Marcum, C., Jr. 1994. Ecology and natural history of four plethodontid species in the Fernow Experimental Forest, Tucker County, West Virginia. M. S. Thesis, Marshall University, Huntington, WV.

Marshall, J. L. 1996. *Eurycea cirrigera* (southern two-lined salamander). Nest site. *Herpetological Review* 27:75-76.

Martof, B. S. 1955. Observations on the life history and ecology of the amphibians of the Athens area, Georgia. *Copeia* 1955:166-170.

Mittleman, M. B. 1966. *Eurycea bislineata. Catalog of American Amphibians & Reptiles* 45.1-45.4.

Noble, G. K., and L. B. Richards. 1932. Experiments on the egg-laying of salamanders. *American Museum Novitates* 513:1-25.

Noble, G. K., and J. A. Weber. 1929. The spermatophore of *Desmognathus* and other plethodontid salamanders. *American Museum Novitates* 351:1-15.

Petranka, J. W. 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C.

Richmond, N. D. 1945. Nesting of the two-lined salamander on the coastal plain. *Copeia* 1945:170.

Sever, D. M. 1972. Geographic variation and taxonomy of *Eurycea bislineata* (Caudata: Plethodontidae) in the upper Ohio River valley. *Herpetologica* 28:314-324.

_____. 1979. Male secondary sexual characters of the *Eurycea bislineata* (Amphibia, Urodela, Plethodontidae) complex in the southern Appalachian Mountains. *Journal of Herpetology* 13:245-253.

Siebert, H. D., and R. A. Brandon. 1960. The salamanders of southeastern Ohio. *Ohio Journal of Science* 60:291-303.

Stewart, M. M. 1956. Certain aspects of the natural history and development of the northern two-lined salamander, *Eurycea bislineata bislineata* (Green), in the Ithaca, New York, region. Ph.D. Dissertation, Cornell University, Ithaca, NY.

_____. 1958. Seasonal variation in the teeth of the two-lined salamander. *Copeia* 1958:190-196.

_____. 1968. Population dynamics of *Eurycea bislineata* in New York. *Journal of Herpetology* 2:176-177.

Verill, A. E. 1863. Notice on the eggs and young of a salamander *Desmognathus fusca* Baird from Maine. *Proceedings of the Boston Society of Natural History* 9:253-255.

Weber, J. A. 1928. Herpetological observations in the Adirondack Mountains, New York. *Copeia* 1928:106-112.

Weichert, C. K. 1945. Seasonal variation in the mental gland and reproductive organs of the male *Eurycea bislineata*. *Copeia* 1945:78-84.

Wilder, H. H. 1899. *Desmognathus fuscus* (Rafinesque) and *Spelerpes bislineatus* (Green). *American Naturalist* 33:231-246.

Wilder, I. W. 1924. The developmental history of *Eurycea bislineata* in western Massachusetts. *Copeia* 1924:77-80.

Wood, J. T. 1949. *Eurycea bislineata wilderae* Dunn. *Herpetologica* 5:61-62.

_____. 1953. The nesting of the two-lined salamander, *Eurycea bislineata*, on the Virginia coastal plain. *Natural History Miscellanea* 122:1-7.

Wood, J. T., and H. N. McCutcheon. 1954. Ovarian egg complements and nests of the two-lined salamander, *Eurycea b. bislineata* x *cirrigera*, from southeastern Virginia. *American Midland Naturalist* 52:433-436.

Wyman, R. L. 1990. What's happening to the amphibians? *Conservation Biology* 4:350-352.

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The Earliest Published Report of Canine Distemper in Maryland - 1759

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Distemper: *"A morbid state of the animal system; indisposition; malady; disorder; — at present chiefly applied to diseases of brutes; as, a distemper in dogs; the horse distemper; the horn distemper in cattle."* - Webster's Revised Unabridged Dictionary (G. & C. Merriam Co., 1913, edited by Noah Porter)

In 1759, Henry Baker (1698-1774), Fellow of the Royal Society, published an account of the weather from 1754-1757 in the then British Province of Maryland (Baker 1759). These records were kept by Dr. Richard Brooke (1716-1783), a physician and surgeon who lived in Prince George's County, Maryland (Papenfuse et al. 1979). Brooke was an early proponent of variolation against smallpox (Cordell 1903) and in 1752 published a letter concerning inoculation against smallpox in the Philosophical Transactions of the Royal Society (Brooke 1752). Along with his observations of the weather, Brooke includes other observations, many of a medical and veterinary nature. They include a description of a disease that afflicted dogs in the summer and fall of 1756 on both the Eastern and Western Shores of Maryland. Below, we review Dr. Brooke's account of this epizootic during colonial times and provide information on recent outbreaks in some non-canine mammals.

Entry for June 1756

"There raged at the same time an epidemical disease amongst the dogs, which destroyed great numbers in all the northern plantations. It came from thence to the eastern shore in Maryland, where it killed most of the dogs. It now rages amongst our dogs, and scarce any recover. They are first seized with a short cough, and a stoppage in the nose, so that they are obliged to breathe thro' the mouth. In four, five, or six days after, they have a large discharge thro' the nostrils of a thick fetid matter, and a plentiful serous discharge from their eyes. Now their stomach fails, or rather they are afraid to eat; for every attempt makes them cough violently, and seems to give them great pain. Some die within two days after this discharge; some live a week, or longer: these have had food forced into their stomachs: but none ever recover, that I have heard of."

This is most likely the earliest report of canine distemper in Maryland. Serious epizootics of canine distemper were also reported in Europe in the 18th century (Kirk 1922). In England, Edward Jenner (1749-1823), who introduced the first smallpox vaccine in 1798 (Jenner 1798), wrote in 1809: *"It may be difficult perhaps to ascertain the period*

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of its first appearance in Britain. In this and the neighbouring counties I have not been able to trace it back much beyond the middle of last century" (Kirk 1922).

Brooke describes the classic symptoms of canine distemper: 1) an initial watery discharge from the nose and eyes, followed by a discharge of pus-filled mucus, 2) loss of appetite, and 3) cough-producing tracheobronchitis (Appel and Summers 1999; Bruner and Gillespie 1973). The death rate from canine distemper is quite variable (Kirk [1922] cites figures ranging from 20 to 90%, but believed ~ 25% to be more accurate), but the high mortality rate often seen is believed to be the result of secondary bacterial infections (Bruner and Gillespie 1973). Edward Jenner stated that canine distemper was *"...as contagious among dogs, as the small-pox, measles, or scarlet fever among human species..."* (Kirk 1922). At the time of the distemper outbreak in Maryland, there was no successful treatment or vaccine for canine distemper.

Dr. Henri Carré (1870-1938) first discovered the viral nature of the agent responsible for canine distemper (Carré 1905). In fact, in France and other French speaking regions of the world, canine distemper is now known as *"la maladie de Carré"* or Carré's disease. Even after Carré's discovery, Ferry (1911, 1912) reported that canine distemper was caused by the bacterium *Bordetella bronchiseptica* (synonyms: *Bacillus bronchicanis* and *Bacillus bronchisepticus*). The viral nature of canine distemper was finally confirmed by Dunkin and Laidlaw (1926). The canine distemper virus (CDV) is a single-stranded RNA *Morbillivirus* in the family Paramyxoviridae (Dimmock & Primrose 1994). The first effective vaccine broadly used against canine distemper employing an inactivated virus preparation was produced by the English scientists Laidlaw and Dunkin (Laidlaw and Dunkin 1928). However, the very first effective vaccine was produced by Puntoni, an Italian (Puntoni 1923). Tizard (1999), in relation to the lack of use of Puntoni's vaccine stated that *"...prior discovery matters little in the face of aggressive publicity. If nobody knows you did the experiment you might as well have never done it in the first place."* The French scientist Lebailly (1927) also produced an effective vaccine using inactivated viruses. For an interesting account of the early history (1795-1920) of attempts to vaccinate against canine distemper see Kirk (1922). A modified live vaccine was first developed by Green and Carlson (1945). The modified live vaccines developed by Haig (1956) and Rockborn (1960) are still used today (Appel 1999).

In Maryland, distemper was quite common until the advent of vaccines, and a veterinarian could typically see several cases each week. Within a decade after the start of routine vaccination, the number of cases seen had fallen to one or two per month (Roger E. Olson, MD State Veterinarian, personal communication). The Maryland Department of Agriculture, Animal Health Laboratory on Maryland's Eastern Shore has not diagnosed a case of distemper (domestic or wildlife) within at least the last several years (Fidelis Hegngi, Director, Animal Health Laboratory, personal communication).

Entry for September 1756

"The disease continues amongst the dogs. This month I saw a tame fox very ill with this disorder. I gave him a dose of a valuable powder, with which I have done much good; and for the knowledge of which I was obliged to my worthy friend Dr. Parsons, when I was last in England. I have known this powder cure dogs; which made

me give it to the fox; but he died in three minutes after; which I attribute to the punch in which I gave it."

Dr. Brooke did not report what compound was used in his attempt to treat the fox. Common home remedies for canine distemper in the 18th century included applying soil plasters over the dog's head, amputation of its ears and tail, pouring pulverized hellebore (probably *Veratrum album* f. Liliaceae) or vinegar into its nose, feeding it tobacco in tree-oil, and putting sulfur into its drinking water. Other treatments included introducing smoke into the nostrils, laxatives, emetics, enemas and vermifuges. Milk, honey and fresh butter were recommended, while bloodletting was not (Grünberg 1997). Jenner (Kirk 1922) was unsuccessful in treating affected dogs: *"I have endeavoured to destroy the contagion by ordering every part of a kennel to be carefully washed with water, then white-washed, and finally to be repeatedly fumigated with the vapour of marine acid, but without any good result."* Marine acid is an archaic term for hydrochloric acid. Bruner and Gillespie (1973) state that this was a common treatment in France in the 18th century.

CDV is one of the most common viral diseases of foxes (Hutchison 1991). Canine distemper is still common in gray foxes in Maryland, and causes greater mortality than all other infectious and non-infectious diseases combined (Davidson et al. 1992). CDV is a significant pathogen among most terrestrial carnivores (order Carnivora) and affects species in all families (Canidae, Mustelidae, Procyonidae, Hyaenidae, Ursidae, Viverridae and Felidae; Williams 2001). There is a fox-specific vaccine used by fox ranchers (Hutchison 1991), but there is none specifically for companion wolves or wolf hybrids. These canids, along with other wild carnivores, can serve as reservoirs for distemper. Transmission between animals is by direct contact with the infectious discharges and by spread of the aerosols from these discharges (Hutchison 1995).

An increase in interest in canine distemper has occurred, resulting from CDV shifting hosts to other carnivores in the late 1980s (see: Harder and Osterhaus 1997). CDV from domestic dogs infected over 85% of lions (*Panthera leo*) in the Serengeti in 1993-1994, with a mortality rate of 35% (Roelke-Parker et al. 1996). Antarctic crabeater seals (*Lobodon carcinophagus*), leopard seals (*Hydrurga leptonyx*; Bengtson and Boveng 1991), and Lake Baikal seals (*Phoca sibirica*; Grachev et al. 1989; Osterhaus et al. 1989) were also infected by direct or indirect contact with domestic dogs. Additionally, CDV has been reported responsible for the mass die-off of Caspian seals (*Pusa caspica*) in spring 2000 (Kennedy et al. 2000). Canine distemper was also found in javelinas (*Tayassu tajacu*, order Artiodactyla, family Tayassuidae; Appel et al. 1991).

Sporadic outbreaks of distemper still occur amongst domestic dogs due to lack of vaccination (Blixenkrone-Møller et al. 1993; Patronek et al. 1995); However, canine distemper was also diagnosed in some previously vaccinated individuals (Blixenkrone-Møller et al. 1993). Harder and Osterhaus (1997) have suggested that some commercial vaccines may not provide resistance against new variants of CDV.

While the origins of canine distemper are unknown, an outbreak of a disease similar to distemper occurred throughout Europe in 1028 and in South America by 1735 (Kirk 1922). It is unclear when distemper first appeared in North America. While modern techniques would be required to validate the diagnosis, it does appear that Brooke's

report (Baker 1759) is the first description of an outbreak of canine distemper in Maryland and perhaps the first in North America.

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Literature Cited

Appel, M.J., C. Reggiardo, B.A. Summers, S. Pearce-Kelling, C.J. Mare, T.H. Noon, R.E Reed, J.N. Shively, and C. Orvell. 1991. Canine distemper virus infection and encephalitis in javelinas (collared peccaries). *Archives of Virology* 119:147-152.

Appel, M.J.G. 1999. Forty years of canine vaccination. *Advances in Veterinary Medicine* 41:309-324.

Appel, M.J.G., and B.A. Summers. 1999. Canine Distemper: Current Status. *In* L. Carmichael (editor). *Recent Advances in Canine Infectious Diseases*. International Veterinary Information Service, Ithaca, NY. (http://www.ivis.org)

Baker, H. 1759. A thermometrical account of the weather, for three years, beginning September 1754 as observed in Maryland by Mr. Richard Brooke. *Philosophical Transactions of the Royal Society* 51:70-82.

Bengtson, J.L., and P. Boveng. 1991. Antibodies to canine distemper virus in Antarctic seals. *Marine Mammal Science* 7:85-87.

Blixenkrone-Møller, M., V. Svansson, P. Have, C. Orvell, M. Appel, I.R. Pedersen, H.H. Dietz, and P. Henriksen. 1993. Studies on manifestations of canine distemper virus infection in an urban dog population. *Veterinary Microbiology* 37:163-73.

Brooke, R. 1752. A letter from Mr. Rich. Brooke, surgeon, to James Parsons, M.D. Secretary to the Royal Society for foreign correspondence, concerning inoculation. *Philosophical Transactions of the Royal Society* 47:470-472.

Bruner, D.W., and J.H. Gillespie. 1973. *Hagan's Infectious Diseases of Domestic Animals, 6th Edition*. Cornell University Press, Ithaca, NY. 1385 pp.

Carré, H. 1905. Sur la maladie des jeunes chiens. *Comptes Rendus de l'Académie des Sciences [III]* 140:689-690 & 1489-1491.

Cordell, E.F. 1903. *The Medical Annals of Maryland, 1799-1899*. Press of Williams & Wilkins Company, Baltimore. 889 pp.

Davidson, W.R., V.F. Nettles, L.E. Hayes, E.W. Howerth, and C.E. Couvillion. 1992. Diseases diagnosed in gray foxes (*Urocyon cinereoargenteus*) from the southeastern United States. *Journal of Wildlife Diseases* 28:28-33.

Dimmock, N. J., and S.B. Primrose. 1994. *Introduction to Modern Virology, 4th Edition*. Blackwell Science Ltd., Cambridge, MA. 384 pp.

Dunkin, G.W., and P.P. Laidlaw. 1926. Studies in dog distemper: III.-The nature of the virus. *Journal of Comparative Pathology* 39:222-230.

Ferry, N.S. 1911. Etiology of canine distemper. *The Journal of Infectious Diseases* 8:399-420.

Ferry, N.S. 1912. *Bacillus bronchisepticus* (*bronchicanis*): The cause of distemper in dogs and similar disease in other animals. *Veterinary Journal* 68:376-391.

Grachev, M.A., V.P. Kumarev, L.V. Mamaev, V.L. Zorin, L.V. Baranova, N.N. Denikina, S.I. Belikov, E.A. Petrov, V.S. Kolesnik, R.S. Kolesnik, V.M. Dorofeev, A.M. Beim, V.N. Kudelin, F.G. Nagieva and V.N. Sidorov. 1989. Distemper virus in Baikal seals. *Nature* 338:209.

Green, R.G. and W.E. Carlson. 1945. The immunization of foxes and dogs to distemper with ferret-passage virus. *Journal of the American Veterinary Medical Association* 107:131-142.

Grünberg, A. 1997. Die Staupe des Hundes - ein Beitrag zur Geschichte der Haustierkrankheiten (Canine distemper - a contribution to the history of pet diseases). Inaugural-Dissertation zur Erlangung des Grades eines Doktors der Veterinärmedizin an der Freien Universität Berlin.

Haig, D.A. 1956. Canine distemper-immunization with avianised virus. *Onderstepoort Journal of Veterinary Research* 27:19-53.

Harder, T.C., and A.D.M.E. Osterhaus. 1997. Canine distemper virus—a morbillivirus in search of new hosts? *Trends in Microbiology* 5:120-124.

Hutchison, T. 1991. *Vaccinating Fur Animals*. Publication No. 91-4. Nova Scotia Department of Agriculture and Fisheries, Halifax, NS.

Hutchison, T. 1995. *Canine Distemper*. Publication No. 95-2. Nova Scotia Department of Agriculture and Fisheries, Halifax, NS.

Jenner, E. 1798. *An Inquiry into the Causes and Effects of the Variolae Vaccinae, a Disease Discovered in Some of the Western Counties of England, Particularly Gloucestershire, and Known by the Name of the Cow Pox*. S. Low, London. 75 pp.

Kennedy, S., T. Kuiken, P.D. Jepson, R. Deaville, M. Forsyth, T. Barrett, M.W.G. van de Bildt, A.D.M.E. Osterhaus, T. Eybatov, C. Duck, A. Kydyrmanov, I. Mitrofanov, and S. Wilson. 2000. Mass die-off of Caspian seals caused by canine distemper virus. *Emerging Infectious Diseases* 6:637-639.

Kirk, H. 1922. *Canine Distemper: Its Complications, Sequelae and Treatment*. Baillière, Tindall and Cox, London. 226 pp.

Laidlaw, P.P., and G.W. Dunkin. 1928. Studies in dog distemper: V.- The immunisation of dogs. *Journal of Comparative Pathology* 41:209-227.

Lebailly, C. 1927. Vaccination préventative et spécifique des chiens contra la maladies du jeune age. *Comptes Rendus Hebdomadaire des Seances de l'Academie des Sciences. Paris* 18:370.

Osterhaus, A.D.M.E., J. Groen, F.G.C.M. UytdeHaag, I.K.G. Visser, M.G.W. Bergman and B. Klingeborn. 1989. Distemper virus in Baikal seals. *Nature* 338:209-210.

Papenfuse, E.C., A.F. Day, D.W. Jordan, and G.A. Stiverson. 1979. *A Bibliographic Dictionary of the Maryland Legislature, 1635-1789. Volume 1:A-H*. The Johns Hopkins University Press, Baltimore.

Patronek, G.J., L.T. Glickman, R. Johnson, and T.J. Emerick. 1995. Canine distemper in pet dogs: II. A case-control study of risk factors during a suspected outbreak in Indiana. *Journal of the American Animal Hospital Association* 31:230-235.

Puntoni, V. 1923. Saggio di vaccinazione anticimurrosa preventiva eseguita per mezzo del virus specifico. *Annali d'Igiene* 33:553-561.

Rockborn, G. 1960. A preliminary report on efforts to produce a living distemper vaccine in tissue culture. *Journal of Small Animal Practice* 1:53.

Roelke-Parker, M. E., L. Munson, C. Packer, R. Kock, S. Cleaveland, M. Carpenter, S.I. O'Brien, A. Pospischil, R. Hofmann-Lehmann, H. Lutz, G.L.M. Mwamengele, M.N. Mgasa, G.A. Machange, B.A. Summers, and M.J.G. Appel. 1996. A canine distemper virus epidemic in Serengeti lions (*Panthera leo*). *Nature* 379:441-445.

Tizard, I. 1999. Grease, anthraxgate, and kennel cough: a revisionist history of early veterinary vaccines. *Advances in Veterinary Medicine* 41:7-24.

Williams, E.S. 2001. Canine distemper. Pages 50-59 *in* E.S. Williams and I.K. Barker (eds). *Infectious Diseases of Wild Mammals, 3rd Edition.* Iowa State University Press, Ames, IA.

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The Vascular Flora of Cove Point, Calvert County, Maryland

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Abstract.—The vascular flora of the Cove Point Liquefied Natural Gas Limited Partnership property at Cove Point, Calvert County, Maryland was surveyed from 1996 to 1999. A voucher specimen was collected for each taxon discovered and deposited in the herbarium of the Cove Point Natural Heritage Trust. A total of 698 species (705 taxa) from 383 genera in 119 families were recorded from the study site. Twelve vascular plant species listed as state endangered or endangered extirpated and three species listed as state threatened were collected from the study area. Additionally, three species ranked as highly state rare or state rare, and 17 species on the state watch list were recorded. Two of the non-native vascular plant taxa, one sedge (*Carex gravida*) and one grass (*Sporobolus indicus*), were first records for Maryland.

Introduction

Study Site

Cove Point, located at approximately 38° 23' north latitude, 76°24' west longitude in Calvert County, Maryland contains 406 ha owned by the Cove Point Liquefied Natural Gas (LNG) Limited Partnership. This area is bordered to the southwest by Cove Point Road, to the east by the Chesapeake Bay, and extends north almost to the main stem of Grays Creek. The barrier wetland lying within the truncated cuspate foreland of Cove Point Cape is approximately 77 ha. Of the 329 ha of upland, 44 are covered by the LNG industrial complex. The remaining upland area (285 ha) is comprised mostly of young, mixed deciduous and coniferous forest, managed meadows and lawns, ponds, creeks, and seeps. The creeks are highly affected by stream capture.

The upland canopy was dominated by rock chestnut oak (*Quercus prinus*), although black oak (*Quercus velutina*), scarlet oak (*Quercus coccinea*), mockernut hickory (*Carya tomentosa*), and pale hickory (*Carya pallida*) were also common along with the conifers Virginia pine (*Pinus virginiana*) and loblolly pine (*Pinus taeda*). American holly (*Ilex opaca*) occurred in the midstory while the shrub layer was dominated by patches of mountain laurel (*Kalmia latifolia*), blueberry (*Vaccinium corymbosum* and *V. pallidum*) and huckleberry (*Gaylussacia baccata*). The herbaceous layer was sparse but diverse with at least 351 species recorded. Numerous seeps, edges of Wilbur Creek and southern tributaries of Grays Creek were often dominated by thick mats of mosses and supported populations of many wetland plant species not found in the barrier wetland at Cove Point. The vascular flora of Cove Point barrier wetland and its associated barrier dune was described by Steury (1999a).

Soils

Matthews (1971) provides a description of soils at Cove Point. Upland soils are primarily composed of Evesboro loamy sand and Sassafras fine sandy loam. The Evesboro series consists of very deep, excessively drained soils, and are the sandiest soils in Calvert County uplands. The Evesboro series have very low available moisture

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capacity, are low in natural plant nutrients, and are strongly to extremely acid. The Sassafras series consists of deep, well drained soils that have a surface layer of brown loamy fine sand about 23 cm thick. They have moderate available moisture capacity, are strongly to extremely acid and warm up early in the spring. Evesboro loamy sand most often occurs on 12 to 35 percent slopes while Sassafras fine sandy loam occurs on 2 to 15 percent slopes. The soils of seeps along Wilbur Creek and along the tributaries of Grays Creek are designated as mixed alluvial. These wet soils were observed to consist of areas of saturated sand, peat or muck. Other soils present on the Cove Point uplands include Westphalia fine sandy loam, Matapeake and Beltsville silt loams, and Rumford-Evesboro gravelly loamy sands. Elevations at Cove Point range from sea level to 34 m above mean sea level.

Climate

Cove Point lies in the Temperate Continental climate zone delineated by Trewartha and Horn (1980). There is no distinct dry season and summers are hot and winters are mild. La Plata, Maryland, 53 km west of Cove Point, at 38°32' north latitude and 77°00' west longitude and an elevation of 42 m, recorded a mean daily maximum temperature of 19.6 °C and a mean daily minimum temperature of 6.9 °C between 1951 and 1980. The month of July recorded the warmest monthly mean temperature of 24.4 °C and January was the coldest month averaging 1.4 °C. The warmest temperature recorded was 39.4 °C in July, 1954 and the coldest temperature was -22.2 °C in January, 1957. An average of 28 days per year reach 32.2 °C or above and an average of 104 days per year reach a minimum temperature that is below freezing (Ruffner and NOAA 1985).

Mean annual precipitation at La Plata is 108 cm. August is the wettest month with a mean precipitation level of 12.5 cm. February is the driest month with only 7.3 cm of precipitation. Snowfall measuring 0.25 cm or more occurs on an average of 72 days per year with a mean annual accumulation of 46.7 cm. Average relative humidity along the Chesapeake Bay is approximately 60% in spring and winter and 75% during summer and autumn. Average frost penetration is about 12.7 cm along the coast of southern Maryland. Prevailing winds are from the northwesterly quadrant at 15.3 kph in winter and southwesterly at 17.7 kph in summer (Ruffner and NOAA 1985).

Methods

The vascular flora of the LNG property at Cove Point was surveyed approximately twice monthly from April through October, 1996 to 1999. The barrier wetland was the focus of search efforts in 1996 and 1997. A canoe was used to access the interior sections of the wetland and the edges were surveyed on foot. Uplands were surveyed in 1998 and 1999. Upland surveys generally followed a meander search pattern while looking for unusual habitat niches where more focused search efforts were conducted. A voucher specimen was collected for each taxon discovered. Unless noted otherwise, all taxa documented in this report are represented by mounted specimens deposited at the herbarium of the Cove Point Natural Heritage Trust. Herbaria acronyms follow Holmgren et al. (1990). Some additional specimens were distributed to COLO, KANU, MARY, MICH, NA, PH, UC, UNA, US, and VDB (Steury 1997, 1999a). The nomenclature and origin of all taxa in this report follow Gleason and Cronquist (1991).

Results

A total of 698 species (705 taxa) from 383 genera in 119 families was recorded from the study site, including 52 species of trees (42 native, two of which were introduced through plantings) and 63 (47 native) species of shrubs and other low woody species. A total of 46 species of vines were recorded, including 19 (15 native) woody vines and 27 (17 native) herbaceous vines. The remaining herbaceous plants found at Cove Point were comprised of 537 species (544 taxa), including 21 species of ferns and other vascular cryptogams, 87 (57 native) species of grasses, 61 (58 native) species of sedges, and 10 species of rushes. Families with the greatest representation of individual species at Cove Point were the Poaceae (87), Asteraceae (75, 77 taxa), Cyperaceae (61, 63 taxa), Fabaceae (39) and Rosaceae (29). Families with the greatest number of native species were Asteraceae (59, 61 taxa), Cyperaceae (58, 60 taxa), Poaceae (57), Fabaceae (19) and Rosaceae (18). Of the 696 species recorded, 24.3% were not native to the northeastern United States.

Two of the non-native vascular plant taxa, one sedge (*Carex gravida*) and one grass (*Sporobolus indicus*), recorded from the Cove Point uplands were first records for Maryland (Steury 1999b; Steury 2000). Based on reviews of Brown and Brown (1984), Mercer (1968), and the Maryland Wildlife and Heritage Division's Biological and Conservation Database (1999), *Agalinis setacea*, *Erianthus alopecuroides*, *Gentiana villosa*, and *Krigia dandelion* are first records for Calvert County. Additionally, Redman (1991) reported *Lycopodium lucidulum* as unrecorded from Calvert County and Hill (1988) published the first record of *Strophostyles leiosperma* from Maryland in Harford County. Both of these taxa are now listed for Calvert County in this report. Twelve vascular plant species listed as state endangered or endangered extirpated, and three species listed as state threatened (Maryland Natural Heritage Program 2001) were collected from the study area. Additionally, three species ranked as highly state rare or state rare, and 17 species on the state watch list were recorded.

Annotated List of Vascular Plants of Cove Point

Families, genera, and species are arranged alphabetically within major taxonomic divisions. Taxa not native to Maryland are denoted by a single asterisk. However some taxa, *Pinus strobus* and *Pinus resinosa* for example, native to the State of Maryland, were likely introduced by humans at Cove Point. The 35 species denoted by a double asterisk are native species listed as rare, threatened or endangered in Maryland by the Maryland Natural Heritage Program (2001). Acronyms are given for each habitat in which a taxon was observed. Four primary habitats were recognized: Cove Point wetland (CPW), barrier dune (BD), dry upland (DU) and wet upland (WU). A taxon which occurred in more that one habitat was noted with the principal association cited first. All voucher specimens are deposited in the herbarium of the Cove Point Natural Heritage Trust, unless designated otherwise using acronyms following Holmgren et al. (1990). Collection numbers are those of the author. A taxon was ranked as "rare" if it was observed to be restricted to a single isolated population, or if not more than 25 plants or flowering stems were observed during the course of the survey.

Lycopodiophyta
Lycopodiaceae
Lycopodium digitatum Dillen—(southern ground cedar) DU. *980817.3*
Lycopodium lucidulum Michx.—(shining clubmoss) WU. Rare. *980702.17*
Lycopodium obscurum L.—(ground pine) DU. *980618.7*

Equisetophyta
Equisetaceae
Equisetum arvense L. (common horsetail) BD, CPW. Rare. *960420.4*

Polypodiophyta
Aspleniaceae
Asplenium platyneuron (L.) Oakes—(ebony spleenwort) DU. *960518.37*
Athyrium filix-femina (L.) Roth var. *asplenioides* (Michx.) Farw.—(southern lady fern) WU. *990619.4*
Athyrium filix-femina (L.) Roth var. *michauxii* Mettenius—(northern lady fern) CPW, WU. *960829.9*
Dryopteris carthusiana (Villars) H.P. Fuchs—(toothed wood-fern) DU. Rare. *990501.4*
Polystichum acrostichoides (Michx.) Schott.—(Christmas fern) DU. *960615.21*
Thelypteris hexagonoptera (Michx.) Weatherby—(southern beech-fern) DU. *980513.4*
Thelypteris noveboracensis (L.) Nieuwl.—(New York fern) DU. *960615.32*
Thelypteris palustris Schott—(marsh fern) CPW, WU. *960725.26*
Blechnaceae
Woodwardia areolata (L.) Moore—(netted chain fern) CPW, WU. *960427.28*
Woodwardia virginica (L.) J. E. Smith—(Virginia chain fern) CPW. *960427.29*
Dennstaedtiaceae
Dennstaedtia punctilobula (Michx.) Moore—(hay-scented fern) DU. *980618.5*
Pteridium aquilinum (L.) Kuhn var. *latiusculum* (Desv.) Underw.—(bracken fern) CPW, DU. Rare. *990804.6*
Onocleaceae
Onoclea sensibilis L.—(sensitive fern) CPW, WU. *960525.19*
Ophioglossaceae
Botrychium biternatum (Savigny) Underwood—(sparce-lobed grapefern) DU. Rare. *980817.5*
Botrychium virginianum (L.) Swartz—(rattlesnake fern) DU. Rare. *980526.18*
Ophioglossum vulgatum L. var. *pycnostichum* Fern.— (southern adder's tongue fern) DU. Rare. *990501.2*
Osmundaceae
Osmunda cinnamomea L.—(cinnamon fern) CPW, WU. *960511.8*

Osmunda regalis L. var. *spectabilis* (Willd.) A. Gray—(royal fern) CPW, WU. *960427.26*

Pinophyta

Cupressaceae

Juniperus virginiana L. var. *crebra* Fern.—(red cedar) BD, CPW, DU. *960601.30*

Pinaceae

Pinus resinosa Aiton—(red pine) DU. Rare, introduced through plantings. *960513.6*

Pinus strobus L.—(white pine) DU. Rare, introduced through plantings. *980627.5*

Pinus taeda L.—(loblolly pine) CPW, DU. *960427.31*

Pinus virginiana Miller—(Virginia pine) DU, CPW. *960511.51*

Taxodiaceae

Taxodium distichum (L.) Rich.—(bald cypress) CPW. Rare (one seedling). *970524.1* (PH)

Magnoliophyta

Acanthaceae

Ruellia caroliniensis (Walter) Steudel—(hairy ruellia) DU. Rare. *960720.5*

Aceraceae

Acer rubrum L.—(red maple) CPW, BD, DU, WU. *960427.30*

Agavaceae

Yucca filamentosa L.—(Adam's needle) DU. Rare. *980526.16*

Alismataceae

Alisma subcordatum Raf.—(southern water-plantain) CPW. *960708.6*

*Sagittaria australis*** (J.G. Smith) Small—(Appalachian arrow-head) WU, CPW. *980817.6*

Sagittaria latifolia Willd.—(common arrowhead) CPW. Rare. *960817.51*

Amaranthaceae

*Amaranthus retroflexus** L.—(rough pigweed) DU. Rare. *981007.2*

Anacardiaceae

Rhus copallinum L.—(dwarf sumac) BD, DU. *960525.32*

Rhus glabra L.—(smooth sumac) BD. Rare. *960518.81*

Rhus typhina L.—(staghorn sumac) DU. *960629.19*

Toxicodendron radicans (L.) Kuntze—(common poison-ivy) BD, CPW, DU. *960518.19*

Annonaceae

Asimina triloba (L.) Dunal—(pawpaw) BD, CPW, DU. *960513.8*

Apiaceae

Aegopodium podagraria L.*—(goutweed) DU. *980618.31*

Cicuta maculata L.—(common water-hemlock) CPW. *960730.5*

Daucus carota L.*—(Queen Anne's lace) BD, DU. *960629.38*

Hydrocotyle ranunculoides L. f. —(buttercup pennywort) CPW. *960427.21*

Hydrocotyle umbellata L.—(water pennywort) CPW. Rare. *960829.27*

Hydrocotyle verticillata Thumb.—(whorled pennywort) CPW. *960629.68*

Oxypolis rigidior (L.) Raf.—(cowbane) CPW. Rare. *960720.32*

Ptilimnium capillaceum (Michx.) Raf.—(Atlantic mock bishop-weed) CPW. *960719.8*

Sanicula canadensis L.—(black snake-root) DU. *960629.17*

Sium suave Walter—(water parsnip) CPW. *960725.12*

Apocynaceae

Apocynum cannabinum L.—(dogbane hemp) BD, DU. *960708.33*

Apocynum sibiricum Jacq.**—(clasping leaved dogbane) BD. *960629.10*

Vinca minor L.*—(periwinkle) DU. Rare. *990501.6*

Aquifoliaceae

Ilex opaca Aiton—(American holly) CPW, DU. *960505.30*

Ilex verticillata (L.) A. Gray—(winterberry) CPW. *960615.13*

Araceae

Arisaema triphylum (L.) Schott—(jack-in-the-pulpit) WU mesic. Rare. *980428.7*

Orontium aquaticum L.—(golden-club) WU. Rare. *980702.2*

Peltandra virginica (L.) Schott & Endl.—(arrow arum) CPW. *960511.2*

Symplocarpus foetidus (L.) Nutt.—(skunk cabbage) CPW, WU. *960427.4*

Araliaceae

Aralia spinosa L.—(Hercules' club) BD, CPW on stumps, DU. *960518.31*

Hedera helix L.*—(English ivy) DU. *960518.25*

Aristolochiaceae

Aristolochia serpentaria L.—(Virginia-snakeroot) DU. Rare. *980513.4*

Asclepiadaeae

Ampelamus albidus (Nutt.) Britton—(sandvine) BD. Rare. *960720.14*

Asclepias amplexicaulis J.E. Smith—(clasping milkweed) DU. Rare. *980803.16*

Asclepias incarnata L. var. *pulchra* (Ehrh.) Pers.—(swamp milkweed) CPW. *960708.14*

Asclepias syriaca L.—(common milkweed) BD, DU. *960615.41*

Asclepias tuberosa L.—(butterfly milkweed) DU. Rare. *980618.20*

Asclepias verticillata L.**—(whorled milkweed) BD. Rare. *960629.26*

Matelea carolinensis (Jacq.) Woodson**—(Carolina spiny anglepod) DU. Rare. *990619.1*

Matelea suberosa (L.) Shinners—(Atlantic angle-pod) CPW edge. Rare. *960629.49*

Asteraceae

Achillea millefolium L.—(common yarrow) BD, DU. *960601.23*

Ambrosia artemisiifolia L.—(common ragweed) BD, DU. *960720.12*

Antennaria plantaginifolia (L.) Richardson—(plantain pussytoes) DU. *980513.33*

Anthemis arvensis L.*—(corn camomile) DU. *980513.17*

Artemisia vulgaris L.*—(mugwort) BD, DU. *960518.79*

Aster divaricatus L.—(common white heart-leaved aster) DU. *980921.3*

Aster lanceolatus Willd. var. *simplex* (Willd.) A. G. Jones—(eastern lined aster) CPW, WU. *961005.10*

Aster lateriflorus (L.) Britton—(goblet aster) DU. *981007.12*

Aster paternus Cronq.—(toothed white-topped aster) DU. *980605.5*

Aster pilosus Willd. var. *pilosus*—(awl aster) DU. *960914.11*

Aster pilosus Willd. var. *pringlei* (A. Gray) S. F. Blake—(awl aster) DU. Rare. *981007.11*

Aster subulatus Michx.—(annual salt-marsh aster) CPW. Rare. *960829.20*

Baccharis halimifolia L.—(groundsel-tree) BD, DU. Rare. *960817.93*

Bidens bipinnata L.—(Spanish needles) BD, DU. *960817.43*

Bidens connata Muhl.—(purplestem beggar-ticks) CPW. Rare. *970913.9*

Bidens discoidea (T. & G.) Britton**—(few-bracted beggar ticks) CPW. *970825.1*

Bidens frondosa L.—(devil's beggar-ticks) WU. Rare. *980908.7*

Bidens laevis (L.) BSP.—(showy bur-marigold) CPW, WU. *970913.11*

Bidens polylepis S.F. Blake*—(Ozark tickseed) DU. *980908.17*

Centaurea maculosa Lam.*—(spotted knapweed) DU. Rare. *980817.8*

Chondrilla juncea L.*—(skeleton weed) BD. *960629.41*

Chrysanthemum leucanthemum L.*—(ox-eye daisy) DU. *960615.4*

Chrysopsis mariana (L.) Elliott—(shaggy golden aster) DU. *980817.12*

Cichorium intybus L.*—(chicory) DU. Rare. *980803.15*

Cirsium discolor (Muhl.) Sprengel—(field-thistle) DU. Rare. *980908.19*

Cirsium vulgare (Savi) Tenore*—(bull thistle) DU. Rare. *980803.19*

Conyza canadensis (L.) Cronq.—(horseweed) BD, DU. *960810.29*

Coreopsis grandiflora Hogg.—(bigflower tickseed) DU. Rare. *990605.7*

Eclipta prostrata (L.) L.*—(yerba-de-tajo) CPW. Rare. *960720.8*

Elephantopus carolinianus Willd.—(leafy elephant's foot) DU. *980817.11*

Elephantopus tomentosus L.**—(tobaccoweed) DU. Rare. *980803.8* (US)

Erechtites hieracifolia (L.) Raf.—(fireweed) CPW, DU. *960817.55*

Erigeron annuus (L.) Pers.—(annual fleabane) DU. *960601.21*

Erigeron philadelphicus L.—(Philadelphia fleabane) DU. *960518.4*

Eupatorium album L.—(white-bracted eupatorium) CPW, DU. *960720.30*

Eupatorium fistulosum Barratt—(hollow-stem joe-pye weed) DU mesic, WU. *980803.7*

Eupatorium hyssopifolium L. var. *hyssopifolium*—(hyssop leaved throughwort) DU. *960810.26*

Eupatorium hyssopifolium L. var. *laciniatum* A. Gray—(hyssop leaved throughwort) DU. Rare. *980721.1*

Eupatorium perfoliatum L.—(bonset) CPW, WU. Rare. *960525.39*

Eupatorium rotundifolium L. var. *ovatum* (Bigel.) Torr.—(round-leaved eupatorium) DU. *960810.11*

Eupatorium serotinum Michx.—(late eupatorium) DU. *980908.5*

Euthamia graminifolia (L.) Nutt. var. *nuttalli* (Greene) W. Stone—(common flat-topped goldenrod) DU. *961005.21*

Gnaphalium obtusifolium L.—(cudweed) BD, DU. *960817.34*

Gnaphalium purpureum L.—(purple cudweed) DU. Rare. *960525.20*

Helianthus annuus L.—(common sunflower) DU. Rare. *960725.10*

Helianthus grosseserratus Martens—(sawtooth sunflower) DU. Rare. *980921.1*

Helianthus tuberosus L.—(Jerusalem-artichoke) DU mesic. *980908.8*

Hieracium gronovii L.—(beaked hawkweed) DU. *980803.20*

Hieracium pilosella L.*—(mouse-ear hawkweed) DU. Rare. *980513.22*

Hieracium venosum L.—(veiny hawkweed) DU. *960615.38*

Hypochoeris radicata L.*—(spotted cat's ear) DU. *960601.25*

Iva frutescens L.—(maritime marsh-elder) BD, CPW. Rare. *960708.65*

Krigia dandelion (L.) Nutt.**—(colonial dwarf dandelion) DU. Rare. *980513.12* (duplicate at US)

Krigia virginica (L.) Willd.—(Virginia dwarf dandelion) DU. *980414.21*

Kuhnia eupatorioides L.—(false boneset) BD. Rare. *960907.10*

Lactuca canadensis L.—(tall lettuce) BD, DU. *960719.16*

Lactuca serriola L.*—(prickly lettuce) BD, DU. *960719.15*

Liatris graminifolia Willd.—(grass-leaved blazing star) DU. *970913.6*

Mikania scandens L. (Willd.)—(climbing hempweed) CPW. *960730.8*

Pluchea odorata (L.) Cass.—(salt-marsh fleabane) CPW. *960817.9*

Prenanthes serpentaria Pursh.—(lion's foot) DU. Rare. *980908.12*

Rudbeckia hirta L.—(black-eyed susan) DU. *980618.8*

Senecio anonymus A. Wood—(Appalachian groundsel) DU. Rare. *980605.8*

Senecio vulgaris L.*—(common groundsel) DU. Rare. *980414.2*

Solidago canadensis L. var. *scabra* T. & G.—(tall goldenrod) BD, DU. *990918.1*

Solidago erecta Pursh—(slender goldenrod) DU. Rare. *980921.10*

Solidago juncea Aiton—(early goldenrod) BD. Rare. 960810.27

Solidago nemoralis Aiton var. *haleana* Fern.—(gray goldenrod) DU. Rare. *981007.7*

Solidago rugosa Miller—(wrinkle-leaf goldenrod) DU. *980908.13*

Solidago sempervirens L.—(seaside goldenrod) BD. *960817.4*

Solidago speciosa Nutt.**—(showy goldenrod) DU. *980921.12* (duplicate at US)

Sonchus asper (L.) Hill*—(prickly sow-thistle) BD, DU. *960719.17*

Taraxacum officinale Weber ex Wiggers*—(common dandelion) DU. *960518.47*

Verbesina occidentalis (L.) Walter—(southern flat-seed sunflower) DU. *980908.11*

Vernonia noveboracensis (L.) Michx.—(New York ironweed) CPW. Rare. *960810.9*

Xanthium strumarium L. var. *canadense* (Miller) T. & G.—(common cocklebur) BD. *960817.31*

Youngia japonica (L.) DC.*—(Asiatic hawk's beard) DU. Rare. *980428.5*

Balsaminaceae

Impatiens capensis Meerb.—(orange jewel-weed) WU. Rare. *980702.4*

Berberidaceae

Podophyllum peltatum L.—(May-apple) DU. *980513.11*

Betulaceae

Alnus serrulata (Aiton) Willd.—(smooth alder) CPW, WU. *960427.24*

Carpinus caroliniana Walter—(hornbeam) DU. *980526.14*

Bignoniaceae

Campsis radicans (L.) Seemann—(trumpet creeper) BD, CPW, DU. *960629.45*

Paulownia tomentosa (Thunb.) Steudel*—(empress tree) DU. *980526.15*

Boraginaceae

Cynoglossum virginianum L.—(wild comfrey) DU. *980513.31*

Echium vulgare L.*—(blue-weed) DU. *990821.2*

Lithospermum arvense L.*—(corn-gromwell) BD. Rare. *960518.39*

Myosotis micrantha Pallas*—(blue forget-me-not) BD. Rare. *990417.8*

Myosotis macrosperma Engelm.**—(large seed forget-me-not) BD, DU. *960518.95*

Brassicaceae

Arabidopsis thaliana (L.) Heynh.*—(mouse-ear cress) DU. *980414.7*

Arabis lyrata L.—(lyre leaved mustard) BD. *960427.12*

Barbarea vulgaris R. Br.*—(common winter cress) DU. *960525.23*

Cakile edentula (Bigelow) Hook—(sea-rocket) BD. *960708.3*

Cardamine hirsuta L.*—(hairy bittercress) DU, CPW edge. *960420.2*

Draba verna L.*—(whitlow mustard) DU. *980414.11*

Lepidium campestre (L.) R. Br.*—(field cress) DU. *980414.4*

Lepidium densiflorum Schrader—(dense-flowered peppergrass) BD, DU. *960629.24*

Lepidium virginicum L.—(poor-man's pepper) DU. *990515.2*

Cabombaceae

Brasenia schreberi J.F. Gemelin—(water shield) WU. *980721.2*

Cactaceae

Opuntia humifusa (Raf.) Raf.—(eastern prickly pear cactus) BD. *960719.18*

Caesalpiniaceae

Chamaecrista fasciculata (Michx.) Greene—(partridge-pea) DU. *980702.20*

Chamaecrista nictitans (L.) Moench—(wild sensitive plant) DU. *980817.1*

Campanulaceae

Lobelia cardinalis L.—(cardinal flower) CPW, WU. *960810.37*

Lobelia inflata L.—(Indian tobacco) DU. *980721.7*

Lobelia puberula Michx.—(downy lobelia) WU mesic. Rare. *980921.9*

Triodanis perfoliata (L.) Nieuwl—(round-leaved triodanis) BD, DU. *960608.18*

Caprifoliaceae

Lonicera japonica Thunb.*—(Japanese honeysuckle) BD, DU, WU. *960525.5*

Lonicera maackii (Rupr.) Maxim.*—(Asian honeysuckle bush) DU. *960518.5*

Lonicera sempervirens L.—(trumpet-honeysuckle) DU. Rare. *990703.2*

Sambucus canadensis L.—(common elder) CPW, WU. *960525.45*

Triosteum perfoliatum L.—(perfoliate horse-gentain) DU. Rare. *960518.58*

Viburnum acerifolium L.—(maple-leaved viburnum) DU. Rare. *960615.26*

Viburnum nudum L.—(possum haw) CPW, WU. *960511.21*

Viburnum prunifolium L.—(black haw) CPW, DU. *960505.10*

Caryophyllaceae

Arenaria serpyllifolia L.*—(tyme leaved sandwort) BD, DU. *960518.34*

Cerastium viscosum L.*— (mouse-ear chickweed) DU. *960427.8*

Cerastium vulgatum L.*— (common mouse-ear chickweed) DU. *960518.51*

Dianthus armeria L.*— (Deptford pink) DU. *960615.1*

Holosteum umbellatum L.*— (jagged chickweed) DU. Rare. *980414.12*

Petrorhagia prolifera (L.) P.W. Ball & Heywood*—(childing pink) BD. *960629.1*

Saponaria officinalis L.*— (bouncing bet) BD. *960629.29*

Scleranthus annuus L.*— (knawel) DU. *980414.3*

Stellaria media (L.) Villars*—(common chickweed) DU. *960427.16*

Celastraceae

Celastrus orbiculatus Thunb.*—(oriental bittersweet) DU. *960817.19*

Celastrus scandens L.—(American bittersweet) DU. Rare. *960518.45*

Euonymus americanus L.—(strawberry-bush) DU. *960615.20*

Euonymus alatus (Thumb.) Siebold*—(winged burning bush) DU. Rare. *990804.4*

Chenopodiaceae

Atriplex hastata L.*—(spearscale) CPW. Rare. *961005.15*

Chenopodium berlandieri Moq. var. *macrocalycium* (Aellen) Cronq.—(pitseed) BD. Rare. *960817.38*

Salsola kali L.—(saltwort) BD. *960817.32*

Cistaceae

Lechea racemulosa Michx.—(many flowered pinweed) DU. *980803.11*

Clethraceae

Clethra alnifolia L.—(coast white alder) CPW, WU. *960427.32*

Clusiaceae

Hypericum canadense L.—(Canada St. John's-wort) CPW. Rare. *960810.14*

Hypericum gentianoides (L.) BSP.—(orange-grass St. John's-wort) DU. Rare. *970913.5*

Hypericum mutilum L.—(dwarf St. John's-wort) CPW, WU. *960730.11*

Hypericum perforatum L.*—(common St. John's-wort) DU. Rare. *980618.3*

Hypericum punctatum Lam.—(spotted St. John's-wort) DU mesic. Rare. *980618.12*

Hypericum stragulum P. Adams & Robson—(decumbent St. Andrew's cross) DU. *960725.8*

Triadenum virginicum (L.) Raf.—(marsh St. John's-wort) CPW. *960720.33*

Triadenum walteri (S. G. Gmelin) Gleason—(Walter's St. John's-wort) CPW. *960725.31*

Commelinaceae

Commelina communis L.*—(Asiatic dayflower) WU, DU. *960629.31*

Commelina virginica L.—(Virginia dayflower) CPW. *960719.1*

Convolvulaceae

Calystegia sepium (L.) R. Br.—(hedge-bindweed) BD, DU. *960525.11*

Convolvulus arvensis L.*—(field-bindweed) DU. *980605.2*

Ipomoea coccinea L.*—(red morning glory) DU. Rare. *981007.3*

Ipomoea hederacea Jacq.—(ivy-leaved morning glory) DU. *980702.14*

Ipomoea lacunosa L.—(white morning glory) DU. *980908.10*

Cornaceae

Cornus racemosa Lam.—(northern swamp dogwood) WU, CPW. *990821.1*

Cornus amomum Miller—(knob-styled dogwood) CPW. Rare. *960518.90*

Cornus florida L.—(flowering dogwood) DU. *960817.15*

Nyssa sylvatica Marshall—(black tupelo) CPW, WU, DU. *960608.10*

Cuscutaceae

Cuscuta compacta A. L. Juss.—(compacted dodder) CPW. Rare. *960829.15*

Cuscuta gronovii Willd.—(common dodder) CPW, WU. *960914.20*

Cyperaceae

Carex alata T. & G.—(winged sedge) CPW, WU. *960720.65*

Carex albicans Willd. var. *emmonsii* (Dewey) Rettig.—(Emmon's sedge) DU. *980414.19*

Carex atlantica L. Bailey var. *atlantica*—(large Atlantic sedge) WU. Rare. *990605.6*

Carex atlantica L. Bailey var. *capillacea* (L. Bailey) Cronquist—(small Atlantic sedge) CPW, WU. *960511.44*

Carex blanda Dewey—(charming sedge) DU. *960518.15*

Carex canescens L.—(gray hairy sedge) CPW. *960427.33*

Carex cephalophora Muhl.—(head-bearing sedge) DU. Rare. *980526.1*

Carex comosa F. Boott—(bearded sedge) CPW. *960608.21*

Carex complanata Torr. & Hook—(flattened sedge) DU, CPW edge. *960720.45*

Carex crinita Lam.—(tasseled sedge) CPW, WU. *960518.12*

Carex debilis Michx.—(weak sedge) CPW, WU. Rare. *960511.41*

Carex digitalis Willd.—(finger sedge) DU. *990515.1*

Carex folliculata L.—(follicled sedge) WU. Rare. *990605.4*

Carex gravida L.H. Bailey var. *lunelliana* (Mackenzie) Hermann*—(heavy sedge) DU. Rare. *990605.1* (duplicate at US)

Carex hyalinolepis Steudel**—(shoreline sedge) CPW. *960601.34*

Carex intumescens Rudge—(swelled sedge) CPW, WU. *960511.39*

Carex laevivaginata (Kuk.) Mackenzie—(smooth-sheathed sedge) CPW. *960511.43*

Carex laxiflora (Lam.)—(loosely-flowered sedge) DU. Rare. *980513.7*

Carex longii Mackenzie—(Long's sedge) CPW. Rare. *960525.58* (MICH)

Carex lurida Wahlenb.—(yellow-green sedge) CPW, WU. *960525.62*

Carex muhlenbergii Schk.—(Muhlenberg's sedge) DU. Rare. *990605.10*

Carex nigromarginata Schwein.—(black margined sedge) DU. Rare. *980414.17*

Carex radiata (Wahlenb.) Small—(stellate sedge) WU, CPW. Rare. *960608.28*

Carex scoparia Schk.—(broom-like sedge) WU. Rare. *990804.2*

Carex seorsa Howe—(separated sedge) CPW, WU. *960505.46*

Carex sparganioides Muhl. var. *aggregata* (Mackenzie) Gleason—(crowed sedge) DU. Rare. *990515.5*

Carex stipata Muhl. var. *maxima* Chapman—(large crowed sedge) CPW. Rare. *960518.10*

Carex stricta Lam.—(erect sedge) CPW. Rare. *960420.6*

Carex styloflexa Buckley**—(bent sedge) WU. Rare. *980428.10*

Carex swanii (Fern.) Mackenzie—(swan's sedge) DU. *960518.16*

Carex venusta Dewey var. *minor* Boeckeler**—(graceful sedge) WU. Rare. *990605.9* (MICH)

Carex vulpinoidea Michx.—(fox tail sedge) CPW, WU, DU mesic. *960525.60*

Cyperus brevifolioides Thieret & Delah.*—(button sedge) CPW edge. *960810.24*

Cyperus echinatus (L.) Wood—(globe-sedge) DU. *960708.22*

Cyperus erythrorhizos Muhl.—(redroot flatsedge) CPW. Rare. *960720.92* (MICH)

Cyperus esculentus L.—(yellow nutsedge) BD. Rare. *961005.2*

Cyperus filicinus Vahl.—(Nuttall's cyperus) CPW. *960817.23*

Cyperus filiculmis Vahl.—(slender cyperus) DU. *980803.18*

Cyperus flavescens L.—(yellow galingale) CPW edge. Rare. *960725.19*

Cyperus irida L.*—(yellow cyperus) DU mesic. Rare. *981007.4*

Cyperus lancastriensis Porter**—(Lancaster's cyperus) DU. Rare. *980702.16*

Cyperus lupulinus (Sprengel) Marcks—(hop cyperus)DU. Rare. *990821.5*

Cyperus odoratus L.—(fragrant galingale) CPW. *020921.6*

Cyperus retrorsus Chapm.—(backward-turned sedge) BD, DU. *960907.4*

Cyperus strigosus L.—(false nutsedge) CPW, WU. *960725.22*

Dulichium arundinaceum (L.) Britton—(three-way sedge) CPW. *960720.39*

Eleocharis flavescens (Poiret) Urban var. *olivacea* (Torr.) Gleason—(green spikerush) CPW, WU. *960829.44*

Eleocharis ovata (Roth) Roemer & Schultes—(blunt spikerush) CPW, WU. *960810.17*

Eleocharis palustris L.—(marsh spikerush) CPW. *960629.99*

Eleocharis tenuis (Willd.) Schultes—(slender spikerush) WU. Rare. *980627.2*

Eleocharis tortilis (Link) Schultes**—(twisted spikerush) CPW, WU. *960810.4*

Fimbristylis autumnalis (L.) Roemer & Schultes—(fall fimbristylis) WU. *980803.23*

Fuirena pumila (Torr.) Sprengel**—(dwarf umbrella-grass) CPW. *960829.32*

Rhynchospora capitellata (Michx.) Vahl.—(small-headed beak-rush) WU. *980803.17*

Rhynchospora capitellata (Michx.) Vahl. forma *controversa* (S.F. Blake) Gale —(small-headed beak-rush) WU. Rare. *980803.17*

Rhynchospora glomerata (L.) Vahl**—(clustered beak-rush) CPW edge. *960720.37*

Rhynchospora gracilenta A. Gray—(slender beak-rush) CPW edge. Rare. *960720.44*

Scirpus americanus Pers.—(Olney-threesquare) CPW. Rare. *960615.36*

Scirpus cyperinus (L.) Kunth—(wool-grass) CPW, WU. *960720.53*

Scirpus polyphyllus Vahl.—(many-leaved bulrush) WU. *980702.3*

Scirpus pungens Vahl—(common threesquare) CPW. *960708.19*

Scirpus robustus Pursh—(saltmarsh bullrush) CPW. Rare. *960719.21*

Scirpus validus Vahl—(great bullrush) CPW. *960810.95*

Dioscoreaceae

Dioscorea quaternata (Walter) J.F. Gmelin—(four-leaved wild yam) DU. Rare. *980513.35*

Dioscorea villosa L.—(colic-root yam) CPW on hummocks, WU mesic. *960511.29*

Elaeagnaceae

Elaeagnus umbellata Thumb.*—(oleaster olive) DU. *960505.18*

Ericaceae

Epigaea repens L.—(trailing arbutus) DU. *960525.47*

Gaylussacia baccata (Wangenh.) K. Koch—(black huckleberry) CPW, DU. *960511.47*

Gaylussacia frondosa (L.) T. & G.—(dangleberry) CPW. *960511.48*

Kalmia latifolia L.—(mountain laurel) DU. *960525.55*

Lyonia ligustrina (L.) DC.—(male-berry) CPW. *960511.13*

Rhododendron periclymenoides (Michx.) Shinn.—(pinkster-flowered azalea) DU. 960513.10

Vaccinium corymbosum L.—(highbush blueberry) CPW, WU, DU. *960511.50*

Vaccinium pallidum Aiton—(hillside blueberry) DU. 980526.13

Vaccinium stamineum L.—(deerberry) DU. Rare. *980702.10*

Euphorbiaceae

Acalypha gracilens A. Gray—(short-stalked copper leaf) DU. Rare. *980817.7*

Acalypha rhomboidea Raf.—(rhombic copperleaf) DU. *960725.20*

Euphorbia corollata L.—(flowering spurge) DU. *980618.29*

Euphorbia maculata L.—(milk-purslane) DU. *960629.52*

Euphorbia nutans Lagasca—(eyebane) BD, DU. *990821.3*

Euphorbia polygonifolia L.—(seaside spurge) BD. *960708.64*

Fabaceae

Amorpha fruticosa L.—(false indigo) BD, DU. *960525.3*

Amphicarpaea bracteata (L.) Fern—(hog-peanut) DU. Rare. *980930.1*

Apios americana Medikus—(groundnut) CPW. *960720.27*

Baptisia tinctoria (L.) R. Br.—(yellow wild indigo) DU. Rare. *980605.4*

Coronilla varia L.*—(crown-vetch) DU. *960615.9*

Desmodium ciliare (Muhl.) DC.—(little leaf tick-trefoil) DU. Rare. *980908.3*

Desmodium glabellum (Michx.) DC.—(a smooth tick-trefoil) DU. *960810.33*

Desmodium laevigatum (Nutt.) DC.**—(smooth tick-trefoil) DU. Rare. *980908.1* (duplicate at US)

Desmodium marilandicum (L.) DC.—(Maryland tick-trefoil) DU. Rare. *980908.2*

Desmodium nudiflorum (L.) DC.—(naked tick-trefoil) DU. *980526.7*

Desmodium paniculatum (L.) DC.—(panicled tick-trefoil) DU. *980908.18*

Desmodium viridiflorum (L.) DC. forma *nuttallii* (Schindl.) Schub.**—(Nuttall's tick-trefoil) DU. Rare. *980908.4* (US)

Galactia volubilis (L.) Britton**—(hairy milk pea) DU. Rare. *980803.12* (*980817.1* US)

Lathyrus latifolius L.*—(everlasting pea) DU. Rare. *990918.3*

Lespedeza cuneata (Dum. Cours.) G. Don.*—(Chinese lespedeza) BD, DU. *960817.48*

Lespedeza procumbens Michx.—(downy trailing lespedeza) DU. *980908.20*

Lespedeza repens (L.) Barton—(smooth trailing lespedeza) DU. *980908.15*

Lespedeza stipulaceae Maxim.*—(Korean clover) BD, DU. *960829.13*

Lespedeza striata (Thumb.) Hook & Arnott*—(Japanese clover) DU. *980817.2*

Lespedeza virginica (L.) Britton—(Virginia lespedeza) DU. Rare. *980908.9*

Lotus corniculatus L.*—(birdsfoot-trefoil) DU. *960615.11*

Medicago lupulina L.*—(black medicago) DU. Rare. *980803.10*

Melilotus alba Medikus*—(white sweet clover) BD, DU. *960629.13*

Melilotus officinalis (L.) Pallas*—(yellow sweet clover) DU. *960525.33*

Pueraria lobata (Willd.) Ohwi*—(kudzu-vine) DU. Rare. *990703.1*

Robinia pseudoacacia L.—(black locust) BD, DU. *960518.66*

Strophostyles helvula (L.) Elliott—(annual woolly bean) BD, DU, CPW on muskrat lodge. *960719.11*

Strophostyles leiosperma (T. & G.) Piper*—(small-flowered woolly bean) DU. Rare. *980803.9* (duplicate at US)

Strophostyles umbellata (Muhl.) Britton—(perennial woolly bean) DU. Rare. *981007.5*

Stylosanthes biflora (L.) BSP—(pencil flower) DU. *980609.9*

Trifolium arvense L.*—(rabbit foot clover) DU. *960629.35*

Trifolium campestre Schreber*—(pinnate hop-clover) BD, DU. *960525.16*

Trifolium dubium Sibth.*—(little hop-clover) DU. *960518.60*

Trifolium pratense L.*—(red clover) DU. *960601.4*

Trifolium repens L.*—(white clover) DU. *960518.56*

Vicia angustifolia L.*—(common vetch) DU. *960525.28*

Vicia cracca L.*—(bird-vetch) DU. *980513.18*

Vicia sativa L.*—(vetch) DU. *960505.5*

Vicia tetrasperma (L.)* Moench—(four-seeded vetch) DU. *960525.25*

Fagaceae

Castanea dentata (Marshall) Borkh.**—(American chestnut) DU. Rare. *960525.38*

Castanea pumila (L.) Miller—(chinquapin) DU. Rare. *991002.2*

Fagus grandifolia Ehrh.—(American beech) DU. *960525.44*

Quercus alba L.—(white oak) DU. *960511.33*

Quercus coccinea Muenchh.—(scarlet oak) DU. *990904.11*

Quercus falcata Michx.—(southern red oak) BD, DU. *960720.20*

Quercus palustris Muenchh.—(pin oak) DU. Rare. *990804.7*

Quercus phellos L.—(willow oak) CPW, DU. *960511.25*

Quercus prinus L.—(chestnut oak) DU. *960615.28*

Quercus rubra L.—(northern red oak) DU. *960525.37*

Quercus stellata Wangenh.—(post oak) DU. *991002.1*

Quercus velutina Lam.—(black oak) DU. *990804.8*

Gentianaceae

Bartonia paniculata (Michx.) Muhl.**—(screw-stem) WU. Rare. *980817.13*

Bartonia virginica (L.) BSP.—(yellow bartonia) CPW, WU. Rare. *960720.58*

Gentiana villosa L.**—(striped gentian) DU. Rare. *981007.6* (duplicate at US)

Obolaria virginica L.—(pennywort) DU. Rare. *980513.13*

Sabatia angularis (L.) Pursh—(common marsh-pink) DU. Rare. *980803.13*

Geraniaceae

Erodium cicutarium (L.) L'Her.*—(stork's bill) DU. Rare. *960518.1*

Geranium carolinianum L. var. *confertiflorum* Fern.—(Carolina cranesbill) DU. *960513.5*

Geranium dissectum L.*—(cut-leaved cranesbill) DU. Rare. *960505.14*

Grossulariaceae

Itea virginica L.—(Virginia willow) CPW, UW. *960511.19*

Haloragaceae

Myriophyllum humile (Raf.) Morong—(low water-milfoil) CPW. Rare. *960601.98*

Proserpinaca palustris L.—(common mermaid weed) CPW. *960629.61*

Hamamelidaceae

Hamamelis virginiana L.—(witch-hazel) DU. Rare. *980605.12*

Liquidambar styraciflua L.—(sweet gum) CPW, BD, DU, WU. *960505.20*

Hydrocharitaceae

Limnobium spongia (Bosc) Steudel**—(American frog's-bit) CPW. *960505.39*

Iridaceae

Iris versicolor L.—(northern blue flag) CPW, WU. *960518.64*

Sisyrinchium angustifolium Miller—(blue-eyed grass) DU, CPW on hummocks. *960525.48*

Juglandaceae

Carya glabra (Miller) Sweet—(pignut hickory) DU. Rare. *980513.32*

Carya pallida (Ashe) Engler & Graebner—(pale hickory) DU. *990804.5* (duplicate at US)

Carya tomentosa (Poiret) Nutt.—(mockernut hickory) DU. *960615.30*

Juglans nigra L.—(black walnut) DU. Rare. *960629.60*

Juncaceae

Juncus acuminatus Michx.—(sharp fruited rush) CPW, WU. *960525.56*

Juncus canadensis J. Gay—(Canada rush) CPW. *960810.7*

Juncus coriaceus Mackenzie—(leathery rush) CPW, WU. *960708.46*

Juncus diffusissimus Buckley—(slimpod rush) WU. Rare. *980702.5*

Juncus effusus L. var. *solutus* Fern. & Wieg. —(soft rush) CPW, WU. *960708.50*

Juncus marginatus Rostk.—(grass-leaved rush) WU. *980627.3*

Juncus scirpoides Lam.—(scirpus rush) WU, CPW edge. *960725.3*

Juncus secundus P. Beauv.—(secund rush) DU. Rare. *980609.11*

Juncus tenuis Willd.—(path rush) DU, CPW edge. *960708.18*

Juncus tenuis Willd. var. *dichotomus* (Elliott) A. Wood—(forked rush) CPW edge. Rare. *960720.91*

Luzula echinata (Small) F.J. Herm.—(seaurchin woodrush) DU. *980513.2*

Lamiaceae

Glechoma hederacea L.*—(gill-over-the-ground) DU. *990501.3*

Lamium amplexicaule L.*—(henbit) DU. *990417.1*

Lamium purpureum L.*—(purple dead nettle) BD, DU. *960505.4*

Lycopus americanus (L.) Elliott—(American water-horehound) CPW. *960719.9*

Lycopus virginicus L.—(Virginia water-horehound) CPW, WU. *960708.41*

Mentha spicata L.*—(spearmint) DU. Rare. *960725.14*

Monarda punctata L.—(horse-mint) BD, DU. *960810.31*

Perilla frutescens (L.) Britton*—(beefsteak plant) DU. *980513.28*

Prunella vulgaris L. var. *lanceolata* (Barton) Fern.—(heal all) DU. *960629.22*

Salvia lyrata L.—(lyre-leaved sage) DU. Rare. *960518.62*

Satureja calamintha (L.) Scheele*—(basil-thyme) BD. *960629.20*

Scutellaria elliptica Muhl.—(hairy skullcap) DU. Rare. *990619.2*

Scutellaria galericulata L.**—(marsh skullcap) CPW. Rare. *960708.8*

Scutellaria integrifolia L.—(large skullcap) DU. Rare. *960720.42*

Scutellaria lateriflora L.—(mad-dog skullcap) CPW. Rare. *960817.46*

Teucrium canadense L.—(American wood sage) CPW edge, BD. *960708.60*

Trichostema dichotomum L.—(blue curls) DU. Rare. *980908.16*

Lauraceae

Sassafras albidum (Nutt.) Nees—(sassafras) DU. *960525.42*

Lemnaceae

Lemna minor L.—(lesser duckweed) CPW. *960427.96*

Lemna perpusilla Torr.—(small duckweed) CPW. *960829.31*

Lemna trisulca L.**—(star duckweed) CPW. *960505.37*

Spirodela polyrhiza (L.) Schleiden—(greater duckweed) CPW. *960505.36*

Lentibulariaceae

Utricularia gibba L.—(creeping bladderwort) CPW. *960720.55*

Utricularia inflata Walter**—(inflated bladderwort) WU. Rare. *990605.2*

Utricularia vulgaris L.—(common bladderwort) CPW. *960513.1*

Lilaceae

Allium vineale L.*—(field garlic) BD, DU. *960615.14*

Asparagus officinalis L.*—(asparagus) BD. Rare. *960518.41*

Hemerocallis fulva (L.) L.*—(day lily) DU. Rare. *960810.22*

Hypoxis hirsuta (L.) Cov.—(common star-grass) DU. Rare. *980609.4*

Ipheion uniflorum (Lindley) Raf.*—(Wisley blue) DU. Rare. *990417.8*

Medeola virginiana L.—(Indian cucumber) DU. *960615.23*

Muscari racemosum (L.) Miller*—(blue-bottle hyacinth) DU. Rare. *990417.5*

Narcissus poeticus L.*—(poet's narcissus) DU. Rare. *990417.6*

Ornithogalum umbellatum L.*—(star of Bethlehem) DU. Rare. *960518.49*

Polygonatum biflorum (Walter) Elliott—(dwarf Solomon's seal) DU. *980513.5*

Smilacina racemosa (L.) Desf.—(false Solomon's seal) DU. Rare. *980618.11*

Uvularia sessilifolia L.—(sessile-leaved bellwort) DU. Rare. *980618.13*

Veratrum viride Aiton—(white hellebore) WU. Rare. *980618.1*

Linaceae

Linum medium (Planchon) Britton var. *texanum* (Planchon) Fern.—(common yellow flax) DU. *980618.18*

Linum striatum Walter—(ridgestem yellow flax) WU. *980618.14*

Lythraceae

Ammannia latifolia L.**—(Koehne's amannia) CPW. *960829.25*

Decodon verticillatus (L.) Elliott.—(swamp loosestrife) CPW. *960725.28*

Magnoliaceae

Liriodendron tulipifera L.—(tulip-tree) CPW, DU, WU. 960525.30

Magnolia virginiana L.—(sweet bay) CPW, WU. *960511.17*

Malvaceae

Hibiscus moscheutos L.—(rose-mallow) CPW. *960720.23*

Hibiscus syriacus L.*—(rose-of-Sharon) DU. Rare. *980627.6*

Kosteletzkya virginica (L.) C. Presl. var. *aquilonia* Fern.—(seashore-mallow) CPW. *960817.7*

Melastomataceae

Rhexia mariana L.—(dull meadow-beauty) DU. *960708.6*

Rhexia virginica L.—(wing-stem meadow-beauty) CPW edge, WU. *960720.36*

Menispermaceae

Menispermum canadense L.—(moonseed) BD, DU. *960518.6*

Mimosaceae

Albizia julibrissin Durazz*—(mimosa) BD. Rare. *970709.2*

Molluginaceae

Mollugo verticillata L.*—(carpet-weed) DU. *980618.28*

Monotropaceae

Monotropa uniflora L.—(Indian pipe) DU. Rare. *980526.6*

Moraceae

Morus alba L.*—(white mulberry) DU. Rare. *980627.7*

Morus rubra L.—(red mulberry) DU. *960518.55*

Myricaceae

Myrica cerifera L.—(wax-myrtle) CPW, BD. *960505.33*

Nymphaeaceae

Nymphaea odorata Aiton—(fragrant water-lily) CPW. Rare. *960608.7*

Oleaceae

Chionanthus virginicus L.—(fringe tree) WU. Rare. *980618.17*

Forsythia viridissima Lind.*—(golden bells) DU. Rare. *990417.2*

Fraxinus pennsylvanica Marshall—(red ash) CPW, DU. *960629.4*

Fraxinus profunda (Bush) Bush**—(pumpkin ash) CPW. *960629.4*

Ligustrum obtusifolium Sieb. & Zucc.*—(Japanese privet) DU. *960601.7*

Ligustrum vulgare L.*—(common privet) DU. *960601.8*

Syringa vulgaris L.*—(common lilac) DU. Rare. *990417.4*

Onagraceae

Circaea lutetiana L.—(common enchanter nightshade) DU. *980618.2*

Epilobium coloratum Biehler—(purple-leaved willow-herb) CPW. Rare. *960829.38*

Ludwigia alternifolia L.—(seedbox) CPW, WU. *960720.18*

Ludwigia palustris (L.) Elliott—(water purslane) CPW, WU. *960720.26*

Oenothera biennis L.—(common evening primrose) BD, DU. *960817.29*

Oenothera laciniata Hill—(cut-leaved evening primrose) DU. Rare. *980702.12*

Orchidaceae

Cypripedium acaule Aiton—(pink lady slipper) DU. *980609.3*

Goodyera pubescens (Willd.) R. Br.—(downy rattlesnake-plantain) DU. Rare. *980609.2*

Habenaria clavellata (Michx.) Sprengel—(club-spur orchid) WU. *980721.6*

Isotria verticillata (Willd.) Raf.—(larger whorled pogonia) DU. Rare. *980721.4*

Orchis spectabilis L.—(showy orchid) DU. Rare. *980513.14*

Spiranthes vernalis Engelm. & A. Gray—(spring ladies' tresses) CPW edge. Rare. *960708.38*

Tipularia discolor (Pursh) Nutt.—(crane fly orchid) DU. Rare. *960427.14*

Orobanchaceae

Epifagus virginiana (L.) Barton—(beech-drops) DU. *981007.13*

Oxalidaceae

Oxalis stricta L.—(common yellow wood-sorrel) DU. *960525.8*

Oxalis violacea L.—(violet wood-sorrel) DU. *980513.39*

Papaveraceae

Sanguinaria canadensis L.—(bloodroot) DU. Rare. *980513.3*

Passifloraceae

Passiflora lutea L.—(yellow passion-flower) DU. *960719.3*

Phytolaccaceae

Phytolacca americana L.—(pokeweed) BD, DU. *960817.40*

Plantaginaceae

Plantago aristata Michx.*—(buckhorn plantain) DU. *990605.3*

Plantago lanceolata L.*—(English plantain) BD, DU. *960518.43*

Plantago rugelii Decne.—(American plantain) DU. *990501.1*

Plantago virginica L.—(hoary plantain) DU. *960525.14*

Platanaceae

Platanus occidentalis L.—(sycamore) DU. Rare. *980618.4*

Poaceae

Agrostis gigantea Roth*—(red top bent-grass) DU. *980702.6*

Agrostis perennans (Walter) Tuckermann—(autumn bent-grass) DU, WU. *980817.9*

*Aira caryophyllea L.**—(silver hairgrass) DU. *980414.22*

Ammophila breviligulata Fern.—(beach grass) BD. 960725.33

Andropogon ternarius Michx.—(splitbeard bluestem) DU. Rare. *980921.2*

Andropogon virginicus L. var. *glaucopsis* (Elliott) A. Hitchc.—(broom-sedge) DU, CPW edge. *960914.4*

Anthoxanthum odoratum L.*—(sweet vernal grass) DU. *980414.15*

Aristida dichotoma Michx.—(churchmouse three-awn grass) DU. *981007.8*

Aristida oligantha Michx.—(prairie three-awn) DU. *980921.5*

Arthraxon hispidus (Thunb.) Makino*—(spike grass) WU. *981007.1*

Arundinaria japonica Siebold & Zucc.*—(arrow bamboo) DU. Rare. *990605.8*

Bromus commutatus Schrader*—(hairy chess) BD. Rare. *960601.37*

Bromus hordeaceus L.*—(soft chess) DU. *980414.16*

Bromus secalinus L.*—(cheat grass) BD, DU. *960615.47*

Bromus sterilis L.*—(barren brome) BD, DU. Rare. *960518.91*

Bromus tectorum L.*—(downy chess) BD, DU. *960505.96*

Cenchrus tribuloides L.—(dune sandbur) BD. *960817.28*

Chasmanthium laxum (L.) Yates—(spikegrass) CPW edge, WU. *960720.48*

Chloris verticillata Nutt.*—(windmill grass) DU. *980721.11*

Cinna arundinacea L.—(common woodreed) CPW, WU. *960829.37*

Cynodon dactylon (L.) Pers.*—(Bermuda-grass) BD, DU. *960720.2*

Dactylis glomerata L.*—(orchard-grass) DU. *980415.5*

Danthonia sericea Nutt.—(downy oatgrass) DU. *980609.10*

Danthonia spicata (L.) F. Beauv.—(poverty oatgrass) DU. *980605.15*

Deschampsia flexuosa (L.) Trin.—(crinkled hairgrass) DU. *980526.5*

Digitaria ischaemum (Schreber) Muhl.*—(smooth crab-grass) DU. *980908.14*

Digitaria sanguinalis (L.) Scop.*—(northern crab-grass) BD, DU. *960914.2*

Distichlis spicata (L.) Greene—(salt-grass) CPW. Rare. *960829.29* (MARY)

Echinochloa crusgalli (L.) P. Beauv.*—(barnyard grass) WU, DU. *980721.1*

Echinochloa muricata (P. Beauv.) Fern.—(a barnyard grass) WU. Rare. *990804.1*

Echinochloa walteri (Pursh) Heller—(Walter's spine grass) CPW. *960817.12*

Eleusine indica (L.) Gaertn.*—(yard grass) DU. *980803.3*

Elymus virginicus L.—(Virginia wild rye) BD, DU. *960629.9*

Eragrostis curvula (Schrader) Nees.*—(weeping lovegrass) DU. *980605.11*

Eragrostis pectinacea (Michx.) Nees.—(Carolina lovegrass) DU. *980721.5*

Eragrostis spectabilis (Pursh) Steudel—(purple lovegrass) BD, DU. *960907.8*

Erianthus alopecuroides (L.) Elliott**—(silver plumegrass) DU. Rare. *980921.11* (duplicate at US)

Festuca elatior L.*—(tall fescue) DU. *980428.3*

Festuca rubra L.—(red fescue) WU. *980513.23*

Glyceria septentrionalis A. Hitchc.—(eastern mannagrass) CPW. Rare. *96960608.23* (MARY)

Glyceria striata (Lam.) A. Hitchc.—(fowl mannagrass) CPW. *960708.66*

Holcus lanatus L.*—(common velvet-grass) DU. *980513.30*

Hordeum pusillum L.—(little barley) DU. *980513.9*

Leersia oryzoides (L.) Swartz—(rice cutgrass) CPW. *960829.40*

Leersia virginica Willd.—(white grass) CPW, WU. *960817.59*

Leptochloa fascicularis (Lam.) A. Gray var. *maritima* (Bicknell) Gleason**—(feather grass) CPW. *960829.22*

Lolium perenne L. var. *aristatum* Willd.*—(ryegrass) DU. *980513.24*

Microstegium vimineum (Trin.) A. Camus*—(Japanese stilt grass) DU. *981007.10*

Muhlenbergia schreberi J.F. Gmelin—(nimblewill grass) DU. *981007.9*

Panicum amarum Elliott—(beach grass) BD. *960817.3*

Panicum anceps Michx.—(flat-stemmed panic grass) DU. *980702.21*

Panicum boscii Poir.—(Bosc's panic grass) DU. *980526.2*

Panicum clandestinum L.—(deer-tongue grass) CPW, DU. *960708.53*

Panicum commutatum Schultes—(variable panic grass) DU. *980526.4*

Panicum depauperatum Muhl.—(starved panic grass) DU. *980605.3*

Panicum dichotomiflorum Michx.—(spreading witch-grass) CPW, DU. *960829.42*

Panicum dichotomum L.—(bushy panic grass) CPW, DU, WU. *960608.25*

Panicum linearifolium Schribn.—(low panic grass) DU. *980609.12*

Panicum rigidulum Nees—(redtop panic grass) CPW edge. *960914.6*

Panicum scoparium Lam.—(velvet panic grass) DU. *980618.32*

Panicum sphaerocarpon Elliott—(round-fruited panic grass) DU. *980609.13*

Panicum verrucosum Muhl.—(verrucose panic grass) CPW edge. *960914.96*

Panicum villosissimum Nash—(white-haired panic grass) DU. *980605.6*

Panicum virgatum L.—(switchgrass) BD, CPW edge, DU. *960810.21*

Parapholis incurva (L.) C. E. Hubard*—(curved joint-grass) BD. Rare. *960615.45* (MARY)

Paspalum dilatatum Poir.*—(dallis-grass) DU, CPW edge. *980609.8*

Paspalum floridanum Michx.—(Flordia paspalum) DU. *980803.6*

Paspalum laeve Michx.—(smooth paspalum) DU. *960708.15*

Phleum pratense L.*—(timothy grass) DU. *980618.24*

Phragmites australis (Cav.) Trin.—(common reed) CPW, BD. *960720.10*

Phyllostachys bambusoides Seib. & Zucc.*—(bamboo) DU. *980526.17*

Poa annua L.*—(speargrass) DU. *980414.6*

Poa compressa L.*—(Canada-bluegrass) BD, DU. *960720.67*

Poa pratensis *.—(Kentucky bluegrass) DU. *980414.4*

Schizachyrium scoparium (Michx.) Nash.—(little bluestem) DU. *970913.4*

Setaria faberi Ritterrm.*—(nodding foxtail grass) DU. *980702.13*

Setaria magna Griseb.—(salt-marsh foxtail-grass) CPW. Rare. *960817.16*

Setaria viridis (L.) P. Beauv.—(green foxtail-grass) BD, DU. *960907.5*

Spartina patens (Aiton) Muhl.—(salt-meadow cord-grass) BD, CPW. *960708.55*

Sorghum halepense (L.) Pers.*—(johnson-grass) DU. Rare. *990717.1*

Sporobolus indicus (L.) R. Br.*—(smut-grass) DU. Rare. *981024.2* (duplicate at US)

Sporobolus vaginiflorus (Torr.) A. Wood—(poverty-grass) DU. *981024.1*

Tridens flavus (L.) A. Hitchc.—(purpletop grass) BD, DU. *960829.6*

Triplasis purpurea (Walter) Chapman—(purple sand grass) BD. *960907.1*

Tripsacum dactyloides (L.) L.—(gama-grass) BD, DU. *960708.57*

Vulpia elliotea (Raf.) Fern.—(squirrel-tail fescue) BD. *960615.44* (MARY)

Vulpia myuros (L.) C. Gmelin*—(rat-tail fescue) DU. *980513.16*

Zizania aquatica L.—(wild rice) CPW. *960810.1*

Zizaniopsis miliacea (Michx.) Doell & Ashchers**—(southern wild rice) CPW. *960708.25*

Polygalaceae

Polygala mariana Miller—(Maryland milkwort) DU. *980605.1*

Polygala sanguinea L.—(blood-milkwort) DU. Rare. *980721.10*

Polygonaceae

Polygonum arenastrum Boreau*—(dooryard knotweed) DU. Rare. *980908.6*

Polygonum arifolium L.—(halberd-leaved tearthumb) CPW, WU. *960817.56*

Polygonum cespitosum Blume var. *longisetum* (De Bruyn) Stewart*—(smartweed) CPW edge. *960725.16*

Polygonum cuspidatum Sieb. & Zucc.*—(Japanese knotwood) DU. Rare. *990918.2*

Polygonum densiflorum Meissner**—(dense-flowered polygonum) CPW. *960914.14*

Polygonum hydropiperoides Michx.—(false water-pepper) CPW. *960829.35*

Polygonum pensylvanicum L.—(Pennsylvania smartweed) DU. Rare. *990804.3*

Polygonum punctatum Elliott—(dotted smartweed) CPW. *960817.53*

Polgonum sagittatum L.—(arrow-leaved tear thumb) WU. *980618.21*

Polygonum scandens L. var. *dumetorum* (L.) Gleason*—(false buckwheat) BD, DU. *960817.37*

Polygonum virginianum L.—(jumpseed) DU. Rare. *980513.38*

Rumex acetosella L.*—(red sorrel) DU. *980414.1*

Rumex crispus L.*—(curly dock) BD, DU. *960525.13*

Rumex obtusifolius L.*—(broad-leaved dock) DU. *960725.27*

Rumex verticillatus L.—(water-dock) CPW. *960525.53*

Pontederiaceae

Pontederia cordata L.—(pickerelweed) CPW. *960615.33*

Portulacaceae

Portulaca oleracea L.*—(common purslane) DU. Rare. *980618.27*

Potamogetonaceae

Potamogeton crispus L.*—(curley pondweed) WU. *980513.1*

Potamogeton diversifolius Raf.—(common snailseed pondweed) WU. Rare. *980921.6*

Potamogeton foliosus Raf.**—(leafy pondweed) CPW. *960817.1*

Potamogeton pectinatus L.—(sago pondweed) WU. *980803.1*

Primulaceae

Anagallis arvensis L.*—(scarlet pimpernel) DU. Rare. *960708.11*

Lysimachia terrestris (L.) BSP.—(bulbil loosestrife) CPW. *960608.17*

Samolus floribundus HBK.—(water pimpernel) CPW. *960601.12*

Pyrolaceae

Chimaphila maculata (L.) Pursh—(spotted wintergreen) DU. *960511.10*

Ranunculaceae

Aquilegia canadensis L.—(Canada columbine) DU. Rare. *960505.12*

Cimicifuga racemosa (L.) Nutt.—(black snakeroot) DU. *980803.5*

Clematis terniflora DC.*—(yam-leaved clematis) BD. *960817.5*

Ranunculus abortivus L.—(small-flowered crowfoot) DU. *960518.29*

Ranunculus bulbosus L.*—(bulbous root buttercup) DU. *960505.3*

Ranunculus sceleratus L.—(cursed crowfoot) CPW. Rare. *960601.11*

Thalictrum pubescens Pursh—(tall meadow-rue) CPW. Rare. *970709.5*

Rosaceae

Agrimonia pubescens Wallr.—(downy agrimony) DU. *980921.4*

Agrimonia rostellata Waller.—(woodland agrimony) DU. *980921.13* (DEK)

Amelanchier arborea (Michx. f.) Fern.— (downy serviceberry) DU. Rare. *990515.5*

Amelanchier canadensis (L.) Medikus—(eastern serviceberry) CPW. *960511.27*

Aronia arbutifolia (L.) Elliott—(red chokeberry) CPW. *960608.5*

Duchesnea indica (Andrews) Focke*—(Indian strawberry) BD, DU. *960511.6*

Fragaria virginiana Duchesne—(thick-leaved wild strawberry) DU. *980513.36*

Geum canadense Jacq.—(white avens) BD, WU, DU. *960629.39*

Potentilla canadensis L.—(running cinquefoil) DU. *980414.23*

Potentilla recta L.*—(sulphur cinquefoil) DU. Rare. *980702.15*

Potentilla simplex Michx.—(old-field five-fingers) DU. *980605.13*

Prunus cerasus L.*—(sour cherry) BD, DU. *960601.17*

Prunus serotina Ehrh.—(wild black cherry) BD, DU. *960513.3*

Pyrus communius L.*—(pear) DU. Rare. *990821.6*

Pyrus malus L.*—(apple) DU. Rare. *980721.12*

Rosa carolina L.—(pasture rose) DU. Rare. *980605.7*

Rosa gallica L.*—(French rose) DU. Rare. *980609.99*

Rosa multiflora Thunb.*—(multiflora rose) DU. *960601.19*

Rosa palustris Marshall—(swamp rose) CPW. *960505.34*

Rosa rugosa Thunb.*—(Japanese rose) BD. Rare. *960601.15*

Rosa wichuraiana Crepin*—(Dorothy Perkins memorial rose) DU. Rare. *980609.98*

Rubus allegheniensis T.C. Porter—(common blackberry) DU. *980526.11*

Rubus argutus Link—(southern blackberry) DU. *960525.1*

Rubus enslenii Tratt—(southern dewberry) DU. Rare. *980618.16*

Rubus hispidus L.—(swamp dewberry) DU. *960708.52*

Rubus occidentalis L.—(black raspberry) DU. *980605.16*

Rubus pensilvanicus Poiret—(Pennsylvania blackberry) DU, CPW, BD. *960608.9*

Rubus phoenicolasius Maxium.*—(wineberry) DU. *980618.25*

Spiraea thunbergii Siebold*—(spiraea) DU. Rare. *990417.3*

Rubiaceae

Cephalanthus occidentalis L.—(button bush) CPW. *960629.63*

Diodia teres Walter—(rough buttonweed) BD, DU. *960629.40*

Diodia virginiana L.—(Virginia buttonweed) WU. Rare. *980618.15*

Galium aparine L. var. *echinospermum* (Wallr.) Farw.—(cleavers bedstraw) BD, DU, WU. *960505.25*

Galium circaezans Michx.—(forest bedstraw) DU. Rare. *990501.5*

Galium lanceolatum Torr.—(wild licorice) DU. *960629.56*

Galium pedemontanum All.*—(madder) DU. Rare. *980414.9*

Galium pilosum Aiton—(hairy bedstraw) BD. *960629.27*

Galium tinctorium L.—(northern three-lobed bedstraw) CPW. *960525.63*

Galium triflorum Michx.—(sweet-scented bedstraw) DU. *960629.57*

Hedyotis caerulea (L.) Hook—(bluets) DU. Rare. *990417.7*

Hedyotis purpurea (L.) T. & G.—(large bluet) DU. *980513.37*

Mitchella repens L.—(partridge-berry) DU, CPW on hummocks. *960427.20*

Sherardia arvensis L.*—(field-madder) DU. *980414.8*

Ruppiaceae

Ruppia maritima L.—(ditch-grass) CPW. *960615.39*

Salicaceae

Populus alba L.*—(white poplar) DU mesic. Rare. *980513.34*

Populus grandidentata Michx.—(big-toothed aspen) WU. Rare. *990515.4*

Populus nigra L.*—(black poplar) BD. Rare. *990717.2*

Salix babylonica L.*—(weeping willow) BD. Rare. *961005.8*

Salix nigra Marshall—(black willow) CPW. Rare. *960505.27*

Sapotaceae

Diospyros virginiana L.—(persimmon) BD, CPW, DU. *960601.36*

Saururaceae

Saururus cernuus L.—(lizard's tail) CPW, WU. *960615.16*

Saxifragaceae

Penthorum sedoides L.—(Virginia stonecrop) WU, CPW. Rare. *980702.1*

Sedum acre L.*—(golden carpet) BD. Rare. *990918.4*

Scrophulariaceae

Agalinis setacea (J.F. Gmelin) Raf.**—(thread agalinis) DU. Rare. *970913.8* (duplicate at OAC)

Aureolaria virginica (L.) Pennell—(downy false foxglove) DU. Rare. *980618.30*

Chelone glabra L.—(white turtlehead) WU. *980526.8*

Gratiola virginiana L.—(round leaved hedge hyssop) CPW, WU. *960511.35*

Linaria canadensis (L.) Dum.-Cours.—(blue toad-flax) BD, DU. *960427.18*

Lindernia dubia (L.) Pennell var. *anagallidea* (Michx.) Cooperrider—(false pimpernel) WU. Rare. *980921.8*

Melampyrum lineare Desr. var. *americanum* (Michx.) Beauverd—(cow-wheat) DU. *980526.3*

Mimulus ringens L.—(Allegheny monkey-flower) WU. Rare. *980817.10*

Verbascum blattaria L.*—(moth mullein) BD. Rare. *960629.33*

Verbascum thapsus L.*—(common mullein) BD, DU. *960629.48*

Veronica arvensis L.*—(corn speedwell) DU. *960505.41*

Veronica hederaefolia L.*—(ivy-leaved speedwell) BD, DU. *960505.8*

Veronica officinalis L.*—(common speedwell) DU. *980513.20*

Veronica peregrina L.—(purslane speedwell) DU. Rare. *980513.19*

Veronica persica Poir.*—(birdseye speedwell) DU. *980414.10*

Veronica serpyllifolia L.*—(thyme-leaved speedwell) DU. *980702.9*

Simaroubaceae

Ailanthus altissima (Miller) Swingle*—(tree of heaven) BD, DU. *960829.1*

Smilacaceae

Smilax bona-nox L.**—(bullbrier) BD, DU. *960518.20*

Smilax glauca Walter—(glaucous catbrier) DU. *980526.10*

Smilax herbacea L.—(carrion-flower) WU. *980428.9*

Smilax hispida Muhl—(bristly greenbrier) DU, CPW. Rare. 960518.9

Smilax rotundifolia L.—(common greenbrier) CPW, BD, DU, WU. *960505.16*

Smilax walteri Pursh—(red-fruited greenbrier) CPW, WU. *960525.65*

Solanaceae

Datura stramonium L.—(Jimson-weed) DU. *960914.13*

Physalis heterophylla Nees.—(clammy groundcherry) DU. Rare. *981024.3*

Solanum carolinense L.—(horse nettle) BD, DU. *960708.30*

Solamun dulcamara L.*—(climbing bittersweet) CPW edge. Rare. *010721.1*

Solanum nigrum L. var. *virginicum* L.—(black nightshade) CPW on muskrat lodge, DU. Rare. *960615.18*

Sparganiaceae

Sparganium americanum Nutt.—(American bur-reed) WU. *980702.7*

Typhaceae

Typha angustifolia L.—(narrow-leaved cat-tail) CPW. *960525.34*

Typha latifolia L.—(common cat-tail) CPW edge. *960708.28*

Typha x glauca Godr.—(hybrid cat-tail) CPW. Rare. *960720.88*

Ulmaceae

Celtis occidentalis L.—(northern hackberry) DU. Rare. *980627.4*

Celtis tenuifolia Nutt.—(dwarf hackberry) BD. Rare. *960518.69*

Ulmus americana L.—(American elm) CPW, DU. *960518.71*

Ulmus rubra Muhl.—(slippery elm) DU. Rare. *960518.88*

Urticaceae

Boehmeria cylindrica (L.) Swartz—(false nettle) CPW, WU. *960708.1*

Valerianacea

Valerianella locusta (L.) Betcke*—(European corn salad) DU. *980428.6*

Valerianella radiata (L.) Dufr.—(beaked corn-salad) BD. Rare. *960518.36*

Verbenaceae

Phryma leptostachya L.—(lopseed) DU. *990515.3*

Phyla lanceolata (Michx.) Greene—(fog fruit) CPW. *960708.13*

Verbena hastata L.—(blue vervain) CPW edge. Rare. *960708.29*

Verbena urticifolia L.—(white vervain) DU. Rare. *980803.2*

Violaceae

Viola arvensis Murray*—(European field pansy) DU. *980513.21*

Viola cucullata Aiton—(blue marsh-violet) WU. *980428.8*

Viola palmata L.—(wood-violet) DU. Rare. *980605.10*

Viola primulifolia L.—(primrose-leaved violet) CPW, WU. *960511.37*

Viola rafinesquii Greene—(wild pansy) DU. *980414.13*

Viola sagittata Aiton—(arrowhead violet) DU. Rare. *980414.24*

Viola sororia Willd.—(dooryard violet) DU. *980513.27*

Viola villosa Walter—(southern woolly violet) DU. *980414.18*

Viscaceae

Phoradendron serotinum (Raf.) M.C. Johnston—(American Christmas-mistletoe) CPW arboreal. Rare. *970524.3*

Vitaceae

Parthenocissus quinquefolia (L.) Planchon—(Virginia creeper) BD, CPW, DU. *960505.28*

Vitis labrusca L.—(fox grape) BD, CPW edge, DU. *960615.7*

Vitis riparia Michx.—(frost grape) DU. *960518.83*

Xyridaceae

Xyris difformis Chapman—(variable yellow-eyed grass) CPW edge, WU. *960810.15*

Literature Cited

Brown, M. L., and R. G. Brown. 1984. *Herbaceous Plants of Maryland.* Port City Press, Inc. Baltimore.

Gleason, H. A., and A. Cronquist. 1991. *Manual of the Vascular Plants of the Northeastern United States and Adjacent Canada. 2nd Edition.* New York Botanical Garden, Bronx.

Hill, S. R. 1988. New plant records for Maryland with an additional note on *Nymphaea tetragona* (Nymphaeaceae) pollination. *Castanea* 53:164-166.

Holmgren, P. K., N. H. Holmgren, and L. C. Barnett. 1990. *Index Herbariorum Part I: The Herbaria of the World. 8th Edition.* New York Botanical Garden, Bronx.

Maryland Natural Heritage Program. 2001. Rare, threatened and endangered plants of Maryland. Maryland Department of Natural Resources, Annapolis.

Matthews, E. D. 1971. Soil survey of Calvert County, Maryland. United States Department of Agriculture, Soil Conservation Service in cooperation with Maryland Agricultural Experiment Station, Washington, DC.

Mercer, W. O. 1968. Taxonomic and ecological survey of the flora of Calvert County, Maryland. Masters thesis, University of Maryland, College Park.

Redman, D.E. 1991. An annotated list of the ferns and fern allies of Maryland and the District of Columbia. *The Maryland Naturalist* 35:15-24.

Ruffner, J. A. and The National Oceanic and Atmospheric Administration. 1985. *Climates of the States. 3rd Edition. Volume I.* Gale Research Company, Detroit, Michigan.

Steury, B. W. 1997. Survey for endangered, threatened and rare vascular plants in Cove Point Marsh, Calvert County, Maryland. *The Maryland Naturalist* 41:89-96.

Steury, B. W. 1999a. Annotated list of vascular plants from a nontidal barrier wetland along the Chesapeake Bay in Calvert County, Maryland. *Castanea* 64:187-200.

Steury, B. W. 1999b. Noteworthy collection from Maryland. *Castanea* 64:271-272.

Steury, B. W. 2000. Noteworthy collection from Maryland. *Castanea* 65:168.

Trewartha, G. T., and L. H. Horn. 1980. *An Introduction to Climate*. McGraw Hill Book Company, New York.

Amphibian And Reptile Inventory At Antietam National Battlefield, Maryland

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Abstract.—We conducted an inventory of amphibian and reptile species at Antietam National Battlefield (ANTI), Washington County, Maryland, from March–November 2000 and from February–September 2001. Our objectives were to (1) review existing literature and documentation dealing with the distribution of amphibians and reptiles in order to develop a database for historical and potential occurrences at ANTI, and (2) document the presence, relative abundance, and distribution of amphibians and reptiles at ANTI based on field surveys. We sampled wetland/riparian, forest, grassland, and fencerow habitats for amphibians and reptiles using nine inventory protocols: visual-encounter surveys (VES), VES coverboard arrays, artificial cover-object (ACO) arrays, drift-fence arrays with funnel traps and pitfall buckets, turtle traps, leaf-litter bags, minnow traps, calling surveys, and general searches. We developed a list of 54 amphibian and reptile species that could potentially occur at ANTI, based on published range maps. Of these potential species, 21 (39%) were observed, including five salamander, six anuran (one toad and five frog species), four turtle, and six snake species. Most species were observed via general searches (21 species) and incidental sightings (12 species). Most individuals were documented in forest habitat (1,071), followed by wetland/riparian habitat (862), fencerow habitat (137), grassland habitat (62), and other habitats (54).

Introduction

The National Park Service (NPS) has determined that park managers need comprehensive information about the biological resources in parks in order to maintain biodiversity and effectively manage natural ecosystems (NPS 1998). One of the first steps to achieve this goal is to conduct baseline inventories of vertebrate and plant species in national parks. Data from such inventories, including the presence and distribution of animals and plants, provide an understanding of the abundance and distribution of park biota and aid in the evaluation of management plans and actions for these species (e.g., Derge et al. 2001).

In 1997, the Maryland Department of Natural Resources inventoried natural areas, waterways, and springs at Antietam National Battlefield (ANTI) for plants, mussels, land snails, and subterranean invertebrates (Maryland Department of Natural Resources 1997). However, virtually no information has been collected on other wildlife species at ANTI. Amphibians and reptiles may constitute a major proportion of the total vertebrate biomass in some ecosystems (e.g., Burton & Likens 1975), but distributions

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and habitat associations of amphibians and reptiles are poorly known compared with those of other vertebrates (DeGraaf & Rudis 1990). Amphibians and reptiles can be important components of the energy flow of some ecosystems (Pough et al. 1987; DeGraaf & Rudis 1990); thus, an understanding of amphibian and reptile populations (e.g., species composition, distribution, and abundance) can be used in assessing the overall health of natural communities. In addition, there is growing concern over recent evidence of worldwide amphibian population declines (Blaustein et al. 1994; Hyde & Simmons 2001), especially with regard to the effects of habitat fragmentation and forest management practices on woodland salamanders (Ash 1988; Wyman 1990; Rodewald & Yahner 1999).

We conducted an inventory of amphibian and reptile species at ANTI in 2000–2001. The overall goal of this project was to document as many species as possible; thus, a variety of sampling protocols was used. The specific objectives of this project were to (1) review existing literature and documentation of NPS and other sources dealing with the distribution of amphibians and reptiles in order to develop a database for historical and potential occurrences of amphibians and reptiles at ANTI, and (2) document the presence, relative abundance, and distribution of amphibians and reptiles at ANTI based on field surveys.

Methods

Study Site

ANTI was established in 1890 to commemorate the Battle of Antietam during the Civil War. This park consists of 1,325 ha in and around the town of Sharpsburg, Washington County, Maryland; approximately 705 ha are under federal ownership (detailed maps are available in Yahner et al. 2001c). The battlefield is mainly comprised of and surrounded by agriculture, which covers 361 ha of the federally owned land. Moreover, local residents farm most of the privately owned land within the park boundary. Another 72 ha of federal land within the boundary are maintained for administrative and other purposes. Overall, nearly 80% (1,053 ha) of the total area within the park boundary is comprised of agriculture, private/municipal properties, and maintained lands. The remaining 272 ha are under federal ownership and consist of 123 ha of grasslands, 122 ha of forest cover, 19 ha of streams and ponds, and 8 ha of old fields (i.e., shrubby grasslands managed for forest regeneration). Forested areas are typically surrounded by pastures and croplands, and range in size from < 1 to 37 ha.

Antietam Creek is the largest stream in the park and is located along the eastern boundary. The chief tributaries of Antietam Creek within the park boundary are Sharpsburg Creek and two others that have no official name. Several springs and cattle ponds also exist at ANTI.

Documented and Potential Species

We searched records at museums (American Museum of Natural History and Carnegie Museum of Natural History) that could have potentially held specimens from Washington County, which includes ANTI. We also reviewed published literature that gave the presence, abundance, and distribution of amphibian and reptile species at ANTI and/or Washington County. Finally, we used a Microsoft Access database to

compile these historical records (Yahner et al. 2001c) and develop a list of species that might potentially occur at the park.

Field Sampling Scheme

We used a USGS aerial photo of ANTI and ArcView GIS software to develop a cover-type map of the park. Water bodies, forest cover, grasslands, agriculture, and lands maintained under federal ownership during our inventory were delineated. We then used the cover-type map to select sampling points for amphibians and reptiles across appropriate habitats in the park.

The selection of sampling points was dependent on sampling constraints and habitat availability (Yahner et al. 2001c). We stratified the selection of primary sampling points into four habitats: wetland/riparian, forest, grassland (neither grazed by cattle nor mowed more than once per year), and fencerows (narrow corridors of tree or shrub vegetation less than 100-m wide and bordered by agricultural fields or pastures). We did not survey croplands because of difficulties in sampling these transitory landscapes. Moreover, previous research suggested that amphibians and reptiles were more likely to be found in our targeted habitats rather than in croplands (Durner & Gates 1993).

A total of 48 official sampling points was used during the inventory. Twenty terrestrial sampling points (12 in forest habitat, four in grassland habitat, and four in fencerow habitat) were established for visual-encounter surveys (VES) and VES coverboard arrays. Sixteen wetland/riparian sampling points were established for general searches. Late in the inventory, 12 sampling points for artificial cover-object (ACO) arrays were subjectively established across all habitats in an effort to document species not already encountered. Some of the 48 sampling points were also used for trapping efforts. From the 20 terrestrial sampling points, a subset of six points (2 per habitat) were randomly selected for terrestrial trapping; aquatic trapping was conducted at eight of the 16 wetland/riparian points, based on water depth and current.

A vehicular route for anuran calling surveys was established along roads within ANTI. Eleven stopping points were established where roads came within close proximity (< 50 m) to a pond, spring, or stream (Zimmerman 1994; Mertz 1996; Yahner et al. 1999). Points were spaced at least 0.6-km apart to avoid overlap of surveys.

Locations of all sampling points were recorded with a GPS unit (Trimble ProXr, accurate to 30–38 cm at ANTI) and downloaded to a GIS file for future reference. Coordinates of the points are provided in Yahner et al. (2001c).

Because amphibians and reptiles cannot be effectively inventoried with a single survey protocol, we employed a combination of survey techniques at ANTI (Yahner et al. 1999). After the first full year of sampling during 2000, we evaluated our results and modified the sampling strategy in an effort to expand the list of species encountered during 2001. Captured animals were identified to species, photographed (if a voucher did not already exist), and released without marking.

Visual-Encounter Survey Protocol.—Visual-encounter surveys (VES) were conducted during daylight hours at the 20 sampling points distributed in forest, grassland, and fencerow habitats. At each sampling point, we centered a 15 x 15 m plot for a VES (Fig. 1). The dimensions of the plot were arbitrarily determined during an inventory project at Gettysburg National Military Park (Yahner et al. 2001b), and were based on

efficiency of sampling while encompassing an area as large as possible. At three riparian sampling sites we conducted a VES within 1 m of a stream bank on both the terrestrial and submerged sides for a 100 m section of stream, using the sampling point as the downstream starting point.

A VES entailed a search beneath all substrates (including logs, coarse woody debris, and rocks) and a visual scanning of the surface and vegetation within either the designated 15 x 15 m plot or the 100 x 2 m stream section (Crump & Scott 1994; Yahner et al. 1999). In order to minimize impacts to microhabitats, rocks and logs that were impossible to lift and then replace in the same or similar condition were not disturbed during our sampling.

VES were conducted at each of the 20 terrestrial sampling points once per month (March–June and September–November 2000, and February–June 2001), with at least 14 days between each survey. Two VES were conducted at three riparian sites in fall 2000, and one was conducted at a single riparian site in spring 2001.

VES Coverboard Array Protocol.—Although capture rates of salamanders may be temporally or spatially variable under coverboards (Hyde & Simmons 2001), they have been shown to be an effective tool for inventorying and monitoring terrestrial salamanders and some reptiles (DeGraaf & Yamasaki 1992; Fitch 1992; Yahner et al. 2001a). We placed an array of coverboards at each forest, grassland, and fencerow sampling point. The arrays incorporated the corners of each of the 15 x 15 m VES plots centered on the 20 terrestrial sampling points. At the four corners of each plot, we placed one large coverboard (1.1 x 40.6 x 122.0 cm) and two small coverboards (2.5 x 20.0 x 100.0 cm), each spaced at least 0.5 m apart (Fig. 1). Large coverboards at each point consisted of corrugated fiberglass at two of the corners and roofing shingles at the other two corners. Small coverboards consisted of pine boards at all corners. We used pairs of small coverboards because salamanders are territorial and often occur in high densities in forest habitats (Droege et al. 1997). Loose substrate (e.g., twigs, leaves, and rocks) was cleared from beneath each board so that boards were flush with the soil surface (Fellers & Drost 1994).

During a VES visit, boards were flipped and any animal occurring underneath a board was identified to species and returned to the ground near the board (Fellers & Drost 1994; Droege et al. 1997; Yahner et al. 1999). The VES coverboard arrays were checked at each terrestrial sampling point at the time of visual-encounter surveys (i.e., once per month March–June and September–November 2000, and February–June 2001).

Artificial Cover-Object Array Protocol.—We established 12 artificial cover-object (ACO) arrays in summer 2001 because VES coverboard arrays were ineffective in attracting snakes during the entire 2000 and spring 2001 sampling seasons. We suspected that the VES coverboards were not of sufficient area to attract large-bodied snakes; thus, we designed arrays that consisted of various relatively large objects as potential cover. These objects included large plywood boards (100 x 100 x 1.2 cm), medium plywood boards (100 x 50 x 1.2 cm), small plywood boards (50 x 50 x 1.2 cm) and black plastic sheets (300 x 122 cm). The use of black plastic sheets was taken from Kjoss & Litvaitis (2001). We used various sizes of plywood boards because we were not aware of a particular size ideal for attracting snakes, and we hoped that a heterogeneous array

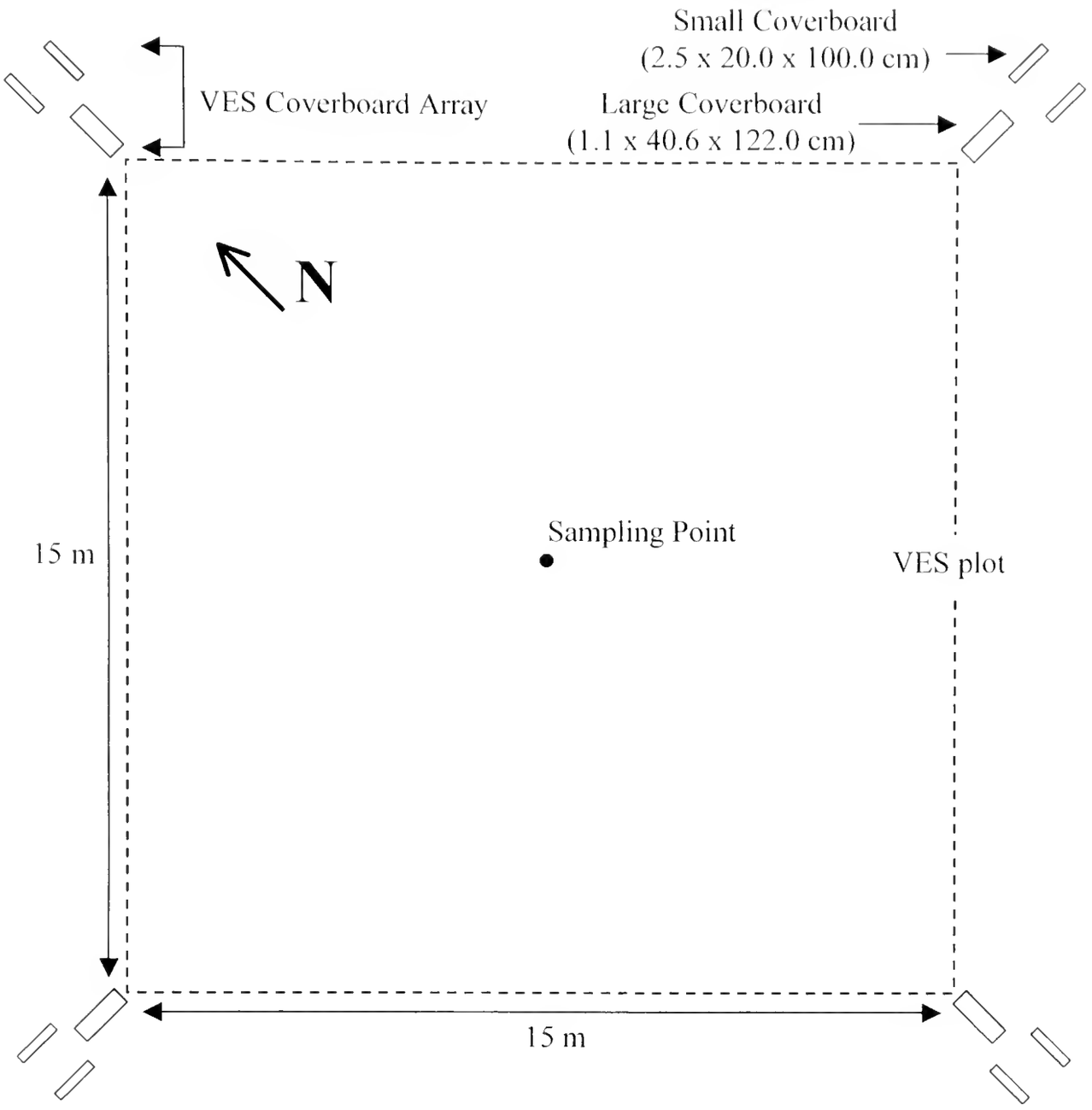

Figure 1. Plot design for visual-encounter surveys (VES) and VES coverboard arrays used to inventory amphibians and reptiles at the 20 forest, grassland and fencerow sampling points at Antietam National Battlefield in 2000 and 2001. The two small coverboards and one large coverboard within each VES coverboard array were spaced approximately 0.5 m apart.

would maximize the chance of attracting a variety of species. Plastic sheets were anchored with nails at the corners and at the centers of the longer sides. Eight ACO arrays followed a particular design (Fig. 2), whereas the other four contained a variable number of objects placed in a more random fashion (see Yahner et al. 2001c).

Locations for the 12 arrays were arbitrarily decided, based on the preferred microhabitats of target snake species. Four arrays were set up in grassland habitat within 5 m of forest edge. Three arrays were set up on forested hillsides and positioned adjacent to rock outcrops. Three arrays were established in riparian zones. One array was set up along a barn and other structures at an old farm, and one array was set up in a regenerating old field (early successional habitat comprised of grasses, shrubs, and young trees).

Unlike the VES coverboard arrays, ACO arrays did not lie flush with the soil surface (grass and leaf litter were not cleared away beneath the objects), and they were checked on multiple occasions during the month (sometimes on consecutive days) from June–September 2001. All arrays were checked together within the same 24-hour time period. Boards were carefully lifted when checking for animals. In checking a plastic sheet, the nails were carefully removed from one side, and the sheet was quickly turned over. If no animals were immediately visible under an object, we sorted through the grass and leaf litter under the object as a means of locating individuals hidden under the grass or litter.

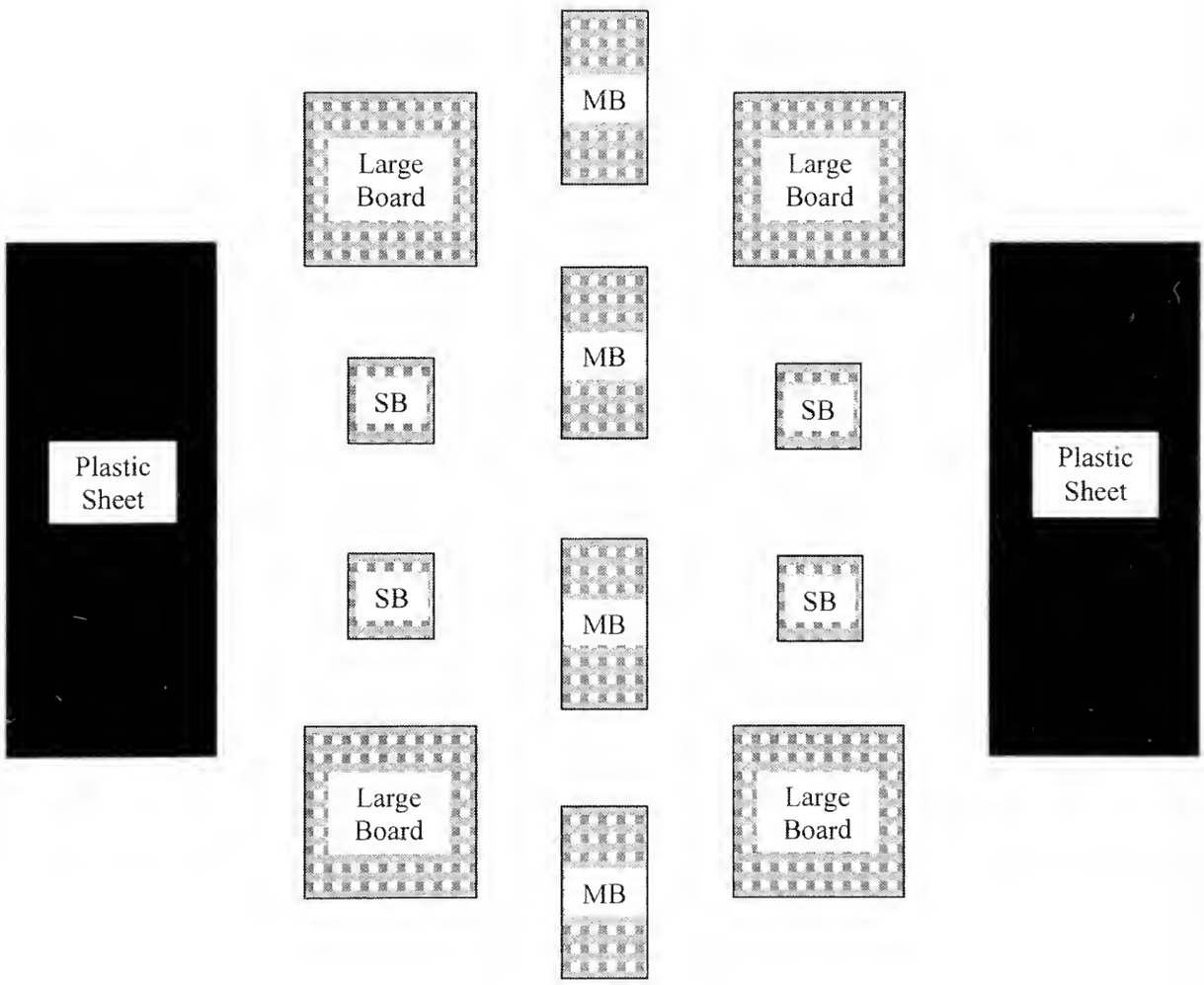

Figure 2. Schematic of the artificial cover-object array used to inventory amphibians and reptiles in grassland edges and on forested hillsides at Antietam National Battlefield in 2001. Cover objects consisted of black plastic sheets and plywood boards and were spaced 0.5 to 1.0 m apart. Plastic sheet = 300 x 122 cm, large board = 100 x 100 x 1.2 cm, medium board (MB) = 100 x 50 x 1.2 cm, and small board (SB) = 50 x 50 x 1.2 cm.

Drift-Fence Array with Funnel Traps and Pitfalls Protocol.—We sampled terrestrial amphibians and reptiles at six sampling points, using a modified Campbell & Christman (1982) trapping array with drift fences (Paulson 1999). In particular, each drift-fence array consisted of three 10 m long segments of plastic silt fence radiating from a central point in a Y-shaped arrangement (see Yahner et al. 2001c). The silt fencing was supported with wooden stakes, and the entire length of the bottom edge of the silt fencing was attached to the ground using landscape staples (in order to prevent animals

from crawling under the fence). At the end of each arm of the fence, as well as at the central point, a pitfall trap was buried flush with the surface of the ground. Each pitfall trap consisted of a 5-gallon plastic bucket and a lid propped with clothespins 5 cm above the rim. The lid served as a rain cover. However, we suspected that the lid might have restricted capture success (especially for turtles and toads). Therefore, during dry spells in 2001 buckets were left uncovered in an effort to maximize catch. A funnel trap was anchored at the midpoint of each arm of the fence and on both sides of each arm. Each funnel trap was constructed of aluminum screening and comprised a cylinder (20 cm in diameter and 80 cm long) with a funnel opening (4–5 cm in diameter) at both ends (Fitch 1951; Greenberg et al. 1994; Enge 1997). A shade cover (WeedBlock premium landscape fabric, Easy Gardener, Inc., Waco, Texas) was placed over each trap.

The drift-fence arrays with funnel traps and pitfalls were placed within 20 m of six randomly selected VES plots. Trapping sessions were repeated once per month in April–July, September, and October 2000, once per month in March and May–July 2001, and twice in April 2001. Pitfalls and funnel traps were opened for 3-9 consecutive days and checked daily. When trapping was not in session, pitfall traps were sealed with a lid and funnel traps were removed.

Turtle Trap Protocol.—We sampled aquatic turtles at one pond and seven sites along Antietam Creek using turtle traps. Traps were commercially available hoop type (76 cm hoop diameter, 9 cm square mesh size, 22 cm entrance diameter) and were baited with canned fish or corn (Plummer 1979). We placed one to four turtle traps, usually distributed at least 10 m apart, in water shallow enough so that at least 15 cm of the traps were above water to allow trapped turtles to breathe. Trapping sessions were conducted once per month in April–July, September, and October 2000, and in April–July 2001. Traps were opened for 3–9 days at a time and checked daily.

Leaf-Litter Bag Protocol.—We sampled aquatic amphibians using leaf-litter bags, which is a relatively new technique effective in capturing larval salamanders (Jung et al. 1999). Leaf-litter bags were constructed of plastic netting (1.5 cm^2 mesh) cut into 50 cm^2 squares. Approximately 1 kg of small rocks, leaves, conifer needles, and/or moss were placed in the center of a square, and the sides were pulled together and cinched with a cable tie. Three to five bags were submerged along the edges of a designated pond or stream. Bags were surrounded by and topped with rocks, and then anchored with string to a tree.

When checking a bag, a dipnet was placed immediately downstream of the bag and the rocks were carefully moved away (noting any amphibians under rocks). The bag was placed in a bucket of water and shaken a sufficient amount of time to dislodge larval amphibians from whatever debris had remained in the bag. The water in the bucket then was poured through the dipnet to capture any amphibians, and the leaf-litter bag was replaced. Captured amphibians were identified to species and released downstream of the bag (Jung et al. 1999). Advantages of this protocol are minimal observer bias (although larval amphibian identification can be challenging to the average observer), ease in achieving large sample sizes, and reduced disturbance to the survey site (Lannoo 1998).

In March 2000 we placed 13 leaf-litter bags in streams and ponds. Bags were checked in April and May 2000. Nearly all bags placed in streams were washed up on the bank or destroyed by floods, and those that remained were ineffective at capturing amphibians. Yahner et al. (2001b) also had little capture success with leaf-litter bags at Gettysburg National Military Park. Therefore, leaf-litter bags were no longer used in our inventory efforts after May 2000.

Minnow Trap Protocol.—We used minnow traps during winter and spring 2001 in an effort to capture adult red-spotted newts (*Notophthalmus viridescens viridescens*) because the species had not been encountered in 2000 using other protocols. Minnow traps (42.0 cm trap length, 22.9 cm trap diameter, 2.5 cm entrance diameter, 0.7 cm standard mesh size) were baited with sardines and placed into bodies of still or slow-moving water.

Traps were used at four sampling points, including a pond and two creeks where fallen trees and other debris created pockets of slow-moving water. Trapping occurred 4–6 days per month (trapping session) in February–April 2001, with one trap placed at three of the four sampling sites for every session. Traps were usually checked daily.

Calling Survey Protocol.—We used a modified version of a protocol established by USGS (2000) to conduct calling surveys at riparian and wetland areas where stream and pond-breeding amphibians could be encountered. Using a vehicular route, an observer stopped at each predetermined point for a count of breeding amphibian calls. Each count was conducted for 3 min following a 1 min equilibrium period. Surveys began 0.5 hours after sunset and were conducted one to four times per month in March–June 2000 and in February–July 2001. Surveys were conducted on multiple occasions because seasonal peaks of frog and toad calling activity differ by species. Surveys typically were not conducted on excessively rainy or windy (>16 km/hr) nights. During each survey, we recorded the species heard and their relative abundance at each stopping point (using a code where 1 = individual calls, 2 = distinguishable but overlapping calls, and 3 = chorus).

General Search Protocol.—The standardized inventory protocols were supplemented with general searches. This protocol had no constraints; researchers were able to canvas areas not otherwise represented in the other protocols. General searches were conducted primarily to expand the list of species encountered, with a focus on searching particular microhabitats during certain weather conditions.

General searches involved both well-known techniques (after Tiebout 1999) and some ad lib methods, such as searching the boundaries of water bodies for animals and egg masses, listening for toad and frog calls, and turning rocks, logs, leaf litter deposits and other substrates. Other methods involved scanning trails, stone walls and rock piles, grasslands, the forest floor, wet roads, vegetation overhanging streams and the interiors of man-made structures (e.g., barns, cannons, cracks in monuments). General searches were conducted during all seasons, both during the day and at night. Although some searches were conducted in 2000, general searches were emphasized more in 2001.

Results

According to published range maps (Behler and King 1996; Conant and Collins 1998; Petranka 1998) and previous records (Table 1), 54 species of amphibians and reptiles potentially occur at ANTI, but we observed only 21 (39%) species. We observed 1,459 salamanders representing five species (38% of potential salamander species), at least 585 toads and frogs representing one toad and five frog species (55% of potential toad and frog species), 102 turtles representing four species (44% of potential turtle species), and 78 snakes representing six species (33% of potential snake species). No lizards (three potential species) were encountered. We did not mark animals and, therefore, we likely counted some individuals more than once (see Yahner et al. 2001c). In the case of toads and frogs, aural observations of choruses made it impossible to document an absolute number of individuals observed, so we documented the minimum number of individuals heard at any particular time.

The redback salamander (*Plethodon cinereus*) was the most commonly encountered species, with a total of 1,223 observations (55% of the total number of amphibian and reptile observations) from March–November 2000 and February–September 2001 (Table 1). The eastern American toad (*Bufo americanus americanus*) was the next most commonly encountered species (20% of the total number of amphibian and reptile observations), and the northern two-lined salamander (*Eurycea bislineata*) was the third most commonly encountered (5% of the total number of amphibian and reptile observations). Details about each species encountered during the inventory, as well as those not encountered, are presented in Yahner et al. (2001c).

Most species were encountered via general searches (21 species) and incidental observations (12 species; Table 2). A moderate number of species was encountered using ACO arrays (10 species), VES (7 species), drift-fence arrays with funnel traps and pitfall buckets (6 species), and calling surveys (6 species). Inventory protocols yielding the fewest species included VES coverboard arrays (4 species), turtle traps (2 species), leaf-litter bags (1 species), and minnow traps (0 species).

The greatest numbers of amphibian and reptile species were encountered in wetland/riparian habitat (18 species), followed by forest habitat (11 species), grassland habitat (8 species), and fencerow habitat (4 species). Six species were found in other habitats, such as roads and barns. The greatest number of observations was made in forest habitat (1,071 individuals), followed by wetland/riparian habitat (862 individuals), fencerow habitat (137 individuals), grassland habitat (62 individuals), and other habitats (54 individuals). Habitat was unknown for 38 observations of northern spring peepers (*Pseudacris crucifer crucifer*).

Discussion

Our inability to document more than 39% of the total number of species that could potentially occur at ANTI, according to range maps (Behler and King 1996; Conant and Collins 1998; Petranka 1998) and previous records (Table 1), may suggest that the park does not provide adequate habitat for some species. We believe this is true for the four-toed salamander (*Hemidactylium scutatum*), Jefferson salamander (*Ambystoma jeffersonianum*), spotted salamander (*Ambystoma maculatum*), Fowler's toad (*Bufo woodhousii fowleri*) and eastern hognose snake (*Heterodon platirhinos*). In the case

Table 1. Species potentially occurring and number of individual amphibians and reptiles documented during field surveys at Antietam National Battlefield in 2000 and 2001.

Potential Species[a]		
Common Name	Scientific Name	No. Individuals Documented[b,c]
Order Caudata – Salamanders		
Four-toed Salamander[d,e]	*Hemidactylium scutatum*	—
Jefferson Salamander[d,e]	*Ambystoma jeffersonianum*	—
Long-tailed Salamander[d,e]	*Eurycea l. longicauda*	81
Marbled Salamander[d,e]	*Ambystoma opacum*	—
Northern Dusky Salamander[d,e]	*Desmognathus f. fuscus*	24
Northern Red Salamander[d,e]	*Pseudotriton r. ruber*	—
Northern Slimy Salamander[d,e]	*Plethodon glutinosus*	10
Northern Spring Salamander[d,e]	*Gyrinophilus p. porphyriticus*	—
Northern Two-lined Salamander[d,e]	*Eurycea bislineata*	121
Redback Salamander[d,e]	*Plethodon cinereus*	1223
Red-spotted Newt[d,e]	*Notophthalmus v. viridescens*	—
Spotted Salamander[d,e]	*Ambystoma maculatum*	—
Valley and Ridge Salamander[d,e]	*Plethodon hoffmani*	—
Order Anura – Toads and Frogs		
Bullfrog[d,e]	*Rana catesbeiana*	11
Eastern American Toad[d,e]	*Bufo a. americanus*	436+
Fowler's Toad[d,e]	*Bufo woodhousii fowleri*	—
Gray Treefrog[d,e]	*Hyla versicolor*	—
Green Frog[d,e]	*Rana clamitans melanota*	63+
Northern Cricket Frog[d,e]	*Acris c. crepitans*	—
Northern Leopard Frog[d,e]	*Rana pipiens*	—
Northern Spring Peeper[d,e,f]	*Pseudacris c. crucifer*	46+
Pickerel Frog[d,e]	*Rana palustris*	23+
Upland Chorus Frog[d,e]	*Pseudacris triseriata feriarum*	—
Wood Frog[d,e]	*Rana sylvatica*	6
Order Testudines – Turtles		
Common Musk Turtle[d,e]	*Sternotherus odoratus*	—
Common Snapping Turtle[d,e]	*Chelydra s. serpentina*	17
Eastern Box Turtle[d,e,f,g,h]	*Terrapene c. carolina*	14
Eastern Mud Turtle[d,e]	*Kinosternon s. subrubrum*	—
Eastern Painted Turtle[d,e]	*Chrysemys p. picta*	68
Redbelly Turtle[d,e]	*Pseudemys rubriventris*	3
Red-eared Slider[d,e]	*Trachemys scripta elegans*	—
Spotted Turtle[d,e]	*Clemmys guttata*	—
Wood Turtle[d,e,g,h]	*Clemmys insculpta*	—

Table 1. Continued

Common Name	Potential Species[a] Scientific Name	No. Individuals Documented[b,c]
Order Squamata		
Suborder Lacertilia – Lizards		
Broadhead Skink[d,e]	*Eumeces laticeps*	—
Five-lined Skink[d,e]	*Eumeces fasciatus*	—
Northern Fence Lizard[d,e]	*Sceloporus undulatus hyacinthinus*	—
Order Squamata		
Suborder Serpentes – Snakes		
Black Rat Snake[d,e,f,h]	*Elaphe o. obsoleta*	16
Corn Snake[d,e,g,h]	*Elaphe g. guttata*	—
Eastern Garter Snake[d,e,f,h]	*Thamnophis s. sirtalis*	15
Eastern Hognose Snake[d,e]	*Heterodon platirhinos*	—
Eastern Milk Snake[d,e,f,g,h,i]	*Lampropeltis t. triangulum*	3
Eastern Ribbon Snake[d,e]	*Thamnophis s. sauritus*	—
Eastern Smooth Earth Snake[d,e]	*Virginia v. valeriae*	—
Eastern Worm Snake[d,e]	*Carphophis a. amoenus*	—
Northern Black Racer[d,e]	*Coluber c. constrictor*	—
Northern Brown Snake[d,e]	*Storeria d. dekayi*	—
Northern Copperhead[d,e,f,h,i]	*Agkistrodon contortrix mokasen*	—
Northern Redbelly Snake[d,e]	*Storeria o. occipitomaculata*	—
Northern Ringneck Snake[d,e]	*Diadophis punctatus edwardsii*	3
Northern Water Snake[d,e,g,h]	*Nerodia s. sipedon*	26
Queen Snake[d,e]	*Regina septemvittata*	15
Rough Green Snake[d,e]	*Opheodrys aestivus*	—
Smooth Green Snake[d,e]	*Opheodrys vernalis*	—
Timber Rattlesnake[d,e]	*Crotalus horridus*	—

[a] The list of potential species was obtained from published range maps, documentation in previous studies, museum records for Washington County, wildlife observation cards at the park, and the NPSpecies database.
[b] Animals were not marked and, therefore, some individuals may have been counted more than once during the inventory.
[c] A "+" indicates that additional, countless numbers of individuals were encountered during calling surveys, general searches, or by incidental observation of calls (e.g., frog choruses).
[d] Documented in Washington County by Harris (1975).
[e] Documented in Washington County in a wildlife database by the Wildlife and Heritage Division of the Maryland Department of Natural Resources (2000).
[f] Documented at Antietam National Battlefield by VanDruff et al. (1992).
[g] Documented at Antietam National Battlefield as "Present in Park" in the NPSpecies database by sources other than the NPFauna database and VanDruff et al. (1992); data are unconfirmed.
[h] Documented at Antietam National Battlefield on Natural History Field Observation Cards submitted by park staff and visitors; data are unconfirmed.
[i] Specimen was collected from Washington County and is located in the herpetology section of the American Museum of Natural History (1999).

Table 2. Number of individual amphibians and reptiles[a], by species and inventory protocol[b], documented at Antietam National Battlefield in 2000 and 2001.

Species	VES[c]	CB	ACO	DFA			TT	LB	MT	CS[d]	GS[d]	IO[d]	Total[e]
				FN	FT	BU							
Long-tailed Salamander	17	2	3	—	—	—	—	—	—	—	59	—	81
Northern Dusky Salamander	—	—	—	—	—	—	—	—	—	—	24	—	24
Northern Slimy Salamander	—	—	1	—	—	—	—	—	—	—	9	—	10
Northern Two-lined Salamander	12	—	11	—	—	—	—	4	—	—	94	—	121
Redback Salamander	346	646	1	1	20	41	—	—	—	—	168	—	1223
Bullfrog	—	—	—	—	—	—	—	—	—	4	2	5	11
Eastern American Toad	2	—	3	—	7	19	—	—	—	51+	331+	23+	436+
Green Frog	—	—	—	—	—	—	—	—	—	8	41+	14	63+
Northern Spring Peeper	—	—	—	—	—	—	—	—	—	44+	1+	1+	46+
Pickerel Frog	1	—	—	—	—	1	—	—	—	9+	10	2	23+
Wood Frog	—	—	—	—	—	—	—	—	—	5	1	—	6
Common Snapping Turtle	—	—	—	—	—	—	4	—	—	—	12	1	17
Eastern Box Turtle	2	—	2	—	—	—	—	—	—	—	1	9	14
Eastern Painted Turtle	—	—	—	—	—	1	1	—	—	—	45	21	68
Redbelly Turtle	—	—	—	—	—	—	—	—	—	—	2	1	3
Black Rat Snake	—	—	1	—	3	—	—	—	—	—	9	3	16
Eastern Garter Snake	1	2	—	2	5	—	—	—	—	—	3	2	15
Eastern Milk Snake	—	1	1	—	—	—	—	—	—	—	1	—	3
Northern Ringneck Snake	—	—	1	—	—	—	—	—	—	—	2	—	3
Northern Water Snake	—	—	2	—	—	—	—	—	—	—	22	2	26
Queen Snake	—	—	—	—	—	—	—	—	—	—	15	—	15
Total[e]	381	651	26	3	35	62	5	4	0	121+	852+	84+	2224+

[a] Animals were not marked and, therefore, some individuals may have been counted more than once during the inventory.
[b] Inventory protocols: VES = visual-encounter survey; CB = VES coverboard array; ACO = artificial cover-object array; DFA = drift-fence array comprised of a drift fence (FN), funnel traps (FT), and pitfall buckets (BU); TT = turtle trap; LB = leaf-litter bag; MT = minnow trap; CS = calling survey; GS = general search. IO = incidental observation (not a survey protocol but rather a chance sighting or aural observation).
[c] Includes riparian visual-encounter surveys.
[d] A "+" indicates that additional, countless numbers of individuals were encountered (e.g., by aural observation of frog choruses).
[e] Total number of individuals encountered, by species and by protocol. Totals with a "+" indicate that additional, unknown numbers of individuals were encountered during calling surveys, general searches, or by incidental observation of calls.

of several turtle species (e.g., common musk turtle [*Sternotherus odoratus*], eastern mud turtle [*Kinosternon subrubrum subrubrum*], and red-cared slider [*Trachemys scripta elegans*]), available water bodies provided some preferred microhabitat conditions (e.g., soft, muddy bottoms) but not others (e.g., dense vegetation). We believe that geographic isolation of small patches of suitable habitat may also explain the apparent absence of some species from ANTI (e.g., marbled salamander [*Ambystoma opacum*], red-spotted newt, spotted turtle [*Clemmys guttata*], broadhead skink [*Eumeces laticeps*], five-lined skink [*Eumeces fasciatus*], northern fence lizard [*Sceloporus undulatus hyacinthinus*], northern copperhead [*Agkistrodon contortrix mokasen*] and timber rattlesnake [*Crotalus horridus*]). Northern copperheads and timber rattlesnakes have historically been persecuted throughout their ranges. We are not aware of past human-snake interactions at ANTI, but the possibility of extirpation of these species exists.

Another explanation for the apparent absence of some species may be that the park lies near the limits of ranges where animal populations probably have spotty distributions. This could help explain why we did not encounter the valley and ridge salamander (*Plethodon hoffmani*), northern leopard frog (*Rana pipiens*), eastern mud turtle, red-eared slider, broadhead skink, corn snake (*Elaphe guttata guttata*), eastern smooth earth snake (*Virginia valeriae valeriae*), northern brown snake (*Storeria dekayi dekayi*), northern redbelly snake (*Storeria occipitomaculata occipitomaculata*), rough green snake (*Opheodrys aestivus*) and smooth green snake (*Opheodrys vernalis*), whose ranges are marginal in the vicinity of ANTI. Additionally, most of these species are secretive and may occur in small numbers, thereby making them difficult to detect. Finally, various land-use activities in and around ANTI (e.g., cattle grazing, mowing, pesticide and fertilizer runoff into water bodies, etc.) could possibly have a negative effect on amphibian and reptile populations.

General searches should be a preferred method in future inventories at ANTI. General searches accounted for all species observed, and they were usually effective regardless of time of day or weather. We do not recommend a design that randomly selects sampling points unless there is an objective to estimate population size, because areas preferred by amphibians and reptiles can easily be missed. If objectives are primarily concerned with documenting the presence and distribution of species, then a thorough searching of all habitats should be performed. As far as standardized protocols are concerned, calling surveys and artificial cover objects can detect a variety of species without requiring much time and labor relative to other protocols (e.g., drift-fence arrays, leaf litter bags, visual-encounter surveys, etc.).

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Literature Cited

Ash, A. N. 1988. Disappearance of salamanders from clearcut plots. *Journal of the Elisha Mitchell Scientific Society* 104:116–122.

Behler, J. L., and F. W. King. 1996. *The Audubon Society Field Guide to North American Reptiles and Amphibians*. Alfred A. Knopf, Inc., New York, New York. 743 pp.

Blaustein, A. R., D. B. Wake, and W. P. Sousa. 1994. Amphibian declines: judging stability, persistence, and susceptibility of populations to local and global extinctions. *Conservation Biology* 8:60–71.

Burton, T. M., and G. E. Likens. 1975. Energy flow and nutrient cycling in salamander populations in the Hubbard Brook Experimental Forest, New Hampshire. *Ecology* 56:1068–1080.

Campbell, H. W., and S. P. Christman. 1982. Field techniques for herpetofaunal community analysis. Pages 193–200 *in* N. J. Scott Jr., editor. *Herpetological communities*. USDI, Fish and Wildlife Service, Research Report 13.

Conant, R., and J. T. Collins. 1998. *A Field Guide to Reptiles and Amphibians: Eastern and Central North America. Third edition*. Houghton Mifflin Company, Boston, Massachusetts. 616 pp.

Crump, M. L., and N. J. Scott, Jr. 1994. Visual encounter surveys. Pages 84–92 *in* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. *Measuring and Monitoring Biological Diversity: Standard Protocols for Amphibians*. Smithsonian Institution Press, Washington, D.C.

DeGraaf, R. M., and D. D. Rudis. 1990. Herpetofaunal species composition and relative abundance among three New England forest types. *Forest Ecology and Management* 32:155-165.

DeGraaf, R. M., and M. Yamasaki. 1992. A nondestructive technique to monitor the relative abundance of terrestrial salamanders. *Wildlife Society Bulletin* 20:260–264.

Derge, K. L., R. H. Yahner, and J. Mravintz. 2001. Survey of reptiles and amphibians in Gettysburg National Military Park with reference to Michaux State Forest. *Journal of the Pennsylvania Academy of Science* 75:43–49.

Droege, S., L. Monti, and D. Lantz. 1997. The terrestrial salamander monitoring program: rationale, protocol, call for participation, and protocological experiments. http://www.mp1-pwrc.usgs.gov/sally/.

Durner, G. M., and J. E. Gates. 1993. Spatial ecology of black rat snakes on Remington Farms, Maryland. *Journal of Wildlife Management* 57:812–826.

Enge, K. M. 1997. Use of silt fencing and funnel traps for drift fences. *Herpetological Review* 28:30–31.

Fellers, G. M., and C. A. Drost. 1994. Sampling with artificial cover. Pages 146–150 *in* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. *Measuring and Monitoring Biological Diversity: Standard Protocols for Amphibians*. Smithsonian Institution Press, Washington, D.C.

Fitch, H. S. 1951. A simplified type of funnel trap for reptiles. *Herpetologica* 7:77–80.

Fitch, H. S. 1992. Protocols of sampling snake populations and their relative success. *Herpetological Review* 23:17–19.

Greenberg, C. H., D. G. Neary, and L. D. Harris. 1994. A comparison of herpetofaunal sampling effectiveness of pitfall, single-ended, and double-ended funnel traps used with drift fences. *Journal of Herpetology* 28:319–324.

Harris, H. S., Jr. 1975. Distributional survey (Amphibia/Reptilia): Maryland and the District of Columbia. *Bulletin of the Maryland Herpetological Society* 11:73–167.

Hyde, E. J., and T. R. Simmons. 2001. Sampling plethodontid salamanders: sources of variability. *Journal of Wildlife Management* 65:624–632.

Jung, R., S. Droege, and J. R. Sauer. 1999. Shenandoah National Park streamside amphibian monitoring protocols and initial results. http://www.mp1-pwrc.usgs.gov/amphib/primenet/shenstreamside.html.

Kjoss, V. A., and J. A. Litvaitis. 2001. Comparison of 2 methods to sample snake communities in early successional habitats. *Wildlife Society Bulletin* 29:153–157.

Lannoo, M. 1998. Protocols and strategies for monitoring North American amphibians: aquatic surveys. http://www.mp1-pwrc.usgs.gov/amphib/tools/proto-aqua.html.

Maryland Department of Natural Resources. 1997. Antietam National Battlefield: Natural areas inventory for rare, threatened, and endangered plants and selected animals with management recommendations. Annapolis, Maryland.

Maryland Department of Natural Resources. 2000. Wildlife and Heritage Division wildlife database. Annapolis, Maryland.

Mertz, L. editor. 1996. Protocols and strategies for monitoring North American amphibians. http://www.mp1-pwrc.usgs.gov/amphib/tools/proto-call.htm.

National Park Service. 1998. NPS inventory and monitoring informational brochure. http://www.nature.nps.gov/im/imbroch.htm.

Paulson, B. 1999. Revised detailed study plan for herpetological inventories of Fort Necessity National Battlefield and Friendship Hill National Historic Site. California University of Pennsylvania. 20 pp.

Petranka, J. W. 1998. *Salamanders of the United States and Canada*. Smithsonian Institution Press, Washington, D.C. 587 pp.

Plummer, M. V. 1979. Collecting and marking. Pages 45–60 *in* M. Harless and H. Morlock, editors. *Turtles: Perspectives and Research*. John Wiley & Sons, New York, New York.

Pough, F. H., E. M. Smith, D. H. Rhodes, and A. Collazo. 1987. The abundance of salamanders in forest stands with different histories of disturbance. *Forest Ecology and Management* 20:1–9.

Rodewald, A. D., and R. H. Yahner. 1999. Effects of forest-management and landscape composition on woodland salamanders. *Northeast Wildlife* 54:45–54.

Tiebout, D. M., III. 1999. Inventorying the herpetofauna of Valley Forge National Historical Park: Full Study Plan. West Chester University, Pennsylvania. 31 pp.

United States Geological Survey. 2000. Protocols for the Vermont calling frog survey. http://www.mp1-pwrc.usgs.gov/amphib/regions/VT%20protocols.html.

VanDruff, L. W., R. H. Bruleigh, T. Ruszkowski, and B. Laniewicz. 1992. Species report: 10 May 1992 – 15 August 1992. SUNY College of Environmental Science and Forestry, Syracuse, New York. Unpublished report. 3 pp.

Wyman, R. L. 1990. What's happening to the amphibians? *Conservation Biology* 4:350–352.

Yahner, R. H., W. C. Bramble, and W. R. Byrnes. 2001a. Effect of vegetation maintenance of an electric transmission right-of-way on reptile and amphibian populations. *Journal of Arboriculture* 27:24–28.

Yahner, R. H., K. L. Derge, and J. Mravintz. 2001b. Inventory of amphibian and reptile species at Gettysburg National Military Park and Eisenhower National Historic Site. National Park Service Technical Report NPS/PHSO/NRTR-01/084. University Park, Pennsylvania. 85 pp.

Yahner, R. H., J. E. Kubel, K. L. Derge, and J. Williams. 2001c. Inventory of amphibians and reptiles at Antietam National Battlefield, Maryland. National Park Service Final Report. University Park, Pennsylvania. 105 pp.

Yahner, R. H., G. L. Storm, G. S. Keller, B. D. Ross, and R. W. Rohrbaugh, Jr. 1999. Inventorying and monitoring protocols of amphibians and reptiles in national parks of the eastern United States. National Park Service Technical Report NPS/PHSO/NRTR-99/076. University Park, Pennsylvania. 109 pp.

Zimmerman, B. L. 1994. Audio strip transects. Pages 92–97 *in* W. R. Heyer, M. A. Donnelly, R. W. McDiarmid, L. C. Hayek, and M. S. Foster, editors. *Measuring and Monitoring Biological Diversity: Standard Protocols for Amphibians*. Smithsonian Institution Press, Washington, D.C.

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